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Instruction Manual

JOHN FLUKE MFG. CO., INC.

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DOCUMENT CONTROL ADMINISTRATOR

ELECTRONICS FOR INDUSTRY

FLUKE

MODEL 825AR/AB

DIFFERENTIAL VOLTMETER

INSTRUMENTS / COMPONENTS

JOHN FLUKE MFG. CO. INC.
P. O. Box 7428 Seattle 33, Washington

June 25, 1962

MODEL 825AR/AB
DIFFERENTIAL VOLTMETER

825A ~~185 to 379~~ 380 ± ov

825AR ~~144 to 233~~ 234 ± ov

825A/AG _____

825AR/AG _____

ERRATA SHEET

MODEL 825AR/AB

The model 825AR/AB is a standard 825AR except it has signal inputs (binding posts) on both front and rear.

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SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

a. This instruction manual is for use with the 825A series Differential DC Voltmeters. The 825A voltmeters are available with either a standard cell or a Zener diode as the reference element. Models containing the Zener diode option are denoted by a /AG in the model number. Both the standard cell option and the Zener diode option are available in a cabinet model or a model designed to fit a standard 19 inch rack. Rack models are denoted by an R immediately following the 825A part of the model number.

b. The high accuracy, portability, and compactness of the 825A make this instrument ideal for the precise measurement of almost any DC voltage. Ease of operation, inherent protection from accidental overload, and high reliability contribute to the outstanding performance that assures suitability for both production line testing and precision laboratory measurements. This instrument is capable of being used as a vacuum tube voltmeter, as a precision potentiometer, and as a megohmmeter for measurement of high resistance. It can also be used to measure the excursions of a voltage about some nominal value. One feature that should be emphasized is that no current is drawn from the unknown source when balance is attained. Thus the determination of the unknown potential is independent of its source resistance. The 825A is basically used for measurements of DC voltages from 0 to 500 volts. However, high accuracy measurements to 30,000 volts DC are possible with precision voltage dividers especially designed for use with the Fluke Model 800 Series Differential Voltmeters. As additional features, this instrument contains a polarity switch for equal convenience in measuring positive or negative voltages and an adjustable recorder output which makes the 825A particularly useful for monitoring the stability of almost any DC voltage. Furthermore, the 825A meter has tautband suspension which eliminates problems due to meter stickiness.

c. When used as a differential voltmeter, the 825A operates on the potentiometric principal. An unknown voltage is measured by comparing it to a known adjustable reference voltage with the aid of a null detector. An accurate standard for measurements is obtained by setting the reference supply with a standard cell for the 825A and 825AR and with a Zener diode for the 825A/AG and 825AR/AG. The known adjustable reference voltage is provided by a 500 volt DC power supply and five Kelvin-Varley decade resistor strings that are set accurately by five voltage readout dials. In this way, the 500 volts can be precisely divided into increments as small as 10 microvolts. The unknown voltage is then simply read from the voltage dials. In the highest null sensitivity range, potential differences between the unknown and the reference voltage of only 0.001 volts will cause full scale meter deflection.

d. The instrument is normally supplied ready for use on 115 volts. Upon request, instruments are supplied for 230 volts operation. If it becomes desirable to convert from one mode of operation to the other, refer to the instruction decal on the back of cabinet models or on the cover in rack models.

1-2. DAMAGE IN SHIPMENT

Immediately upon receipt, thoroughly inspect for any damage that may have occurred in transit. If any damage is noted, follow the instructions outlined on the warranty page at the back of this manual.

1-3. SPECIFICATIONS

AS A PRECISION POTENTIOMETER

ACCURACY: ±0.02 % of input voltage from 0.1 volt to 500 volts. ±(0.02 % + 25 uv) below 0.1 volt.

RANGE

Input Voltage Range	Recommended Null Range*	Input Resistance per volt of input voltage	
		At Null	1% of Full Scale Off Null
50-500	10-0-10	Infinite	100 Meg
	1-0-1	Infinite	1,000 Meg
5-50	1-0-1	Infinite	1,000 Meg
	0.1-0-0.1	Infinite	10,000 Meg
0.5-5	0.1-0-0.1	Infinite	10,000 Meg
	0.01-0-0.01	Infinite	100,000 Meg
0-0.5	0.01-0-0.01	Infinite	100,000 Meg
	0.001-0-0.001	Infinite	100,000 Meg

*Any null range may be used with any input voltage range; recommended ranges are those most useful.

RESOLUTION: Voltage Readout Dial Resolution

Range Setting	Null Setting	Resolution
500	any	10 mv
50	any	1 mv
5	any	0.1 mv
0.5	any	0.01 mv

Meter Resolution
(1/4 of a small scale meter division)

Range Setting	Null Setting	Resolution
any	10	50 mv
any	1	5 mv
any	0.1	0.5 mv
any	0.01	0.05 mv
any	0.001	0.005 mv

AS A VACUUM TUBE VOLTMETER

ACCURACY: 3% on all ranges

RANGE:

Voltage Ranges	Input Resistance
500-0-500	50 Meg
50-0-50	50 Meg
5-0-5	50 Meg
0.5-0-0.5	50 Meg
10-0-10*	10 Meg
1-0-1*	10 Meg
0.1-0-0.1*	10 Meg
0.01-0-0.01*	10 Meg
0.001-0-0.001*	1 Meg

*These ranges are obtained by using Null ranges with all five voltage readout dials set to 0.

GENERAL SPECIFICATIONS

STABILITY OF REFERENCE SUPPLY:

±0.0025% for a 10% change in line voltage.

STABILITY OF METER ZERO:

±0.5% of full scale for a 10% change in line voltage.

INPUT POWER:

115/230 volts AC (105-130/210-260 volts AC), 50-400 cps, 60 watts.

DIMENSIONS:

Cabinet Model - 13" high, 9-3/4" wide, 14" deep.
Rack Model - 7" high, 19" wide, 14" deep.

WEIGHT:

Cabinet Model - 25 lbs.
Rack Model - 22 lbs.

SECTION II

OPERATING INSTRUCTIONS

2-1. CONTROLS, TERMINALS, AND INDICATORS

The location, circuit symbol, and a functional description of external controls, terminals, and indicators on the 825A Precision Differential DC Voltmeter may be found in figure 2-1.

CONTROLS TERMINALS AND INDICATORS	LOCATION	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
Input terminals	Front panel	J1, J3	Provided for connecting DC voltage to be measured.
Chassis ground terminal	Front panel	J2	Provided for grounding purposes. A 0.47 uf capacitor is connected from the lower input binding post to the chassis ground post. The upper input post should never be connected to the chassis ground post. Since the instrument is equipped with a three-wire line cord with the third wire fastened to the chassis, the external circuit should be checked for conflicts in grounding before connecting lower input binding post (middle post) to the chassis post.
Power toggle switch	Front panel	S1	Applies AC line voltage to the primary circuit of the power transformer.
OPERATE-CALIBRATE switch	Front panel	S4	Remains in the OPERATE position at all times except when it is necessary to calibrate the internal 500 volt DC reference supply. When held in the CALIBRATE position, a representative sample of the reference voltage is compared to the voltage of an internal standard cell, or Zener diode for the /AG models, and any difference is indicated on the meter.
CALIBRATE control	Front panel	R2	Varies the output of the 500 volt DC reference supply. When the OPERATE-CALIBRATE switch is held in the CALIBRATE position, the reference supply is accurately set by adjusting the CALIBRATE control for zero meter deflection.
RANGE switch	Front panel	S2	Selects desired voltage range. Full scale voltage ranges of 500, 50, 5, and 0.5 volts are available.

Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS. (Sheet 1 of 2)

CONTROLS TERMINALS AND INDICATORS	LOCATION	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
NULL switch	Front panel	S3	Set to VTVM for determining the approximate value of unknown voltage prior to differential measurements. Five null voltage ranges of 10, 1, 0.1, 0.01, and 0.001 volts are used for differential measurements. These ranges represent full scale differences between the unknown voltage and the amount of precision internal reference voltage that is set on the voltage readout dials.
A, B, C, D, and E voltage readout dials	Front panel	S6, S7, S8, S9, S10	Provide an in- line readout of the amount of internal reference voltage necessary to null the unknown voltage.
Decimal lights	Front panel	DS1, DS2, DS3, DS4	Serve as decimal points for the voltage readout dials. A different light illuminates for each position of the RANGE switch.
Polarity switch	Front panel	S5	Changes polarity of 825A to match polarity of unknown voltage. With this switch in the positive position, the polarity of the upper input binding post is positive with respect to the lower input binding post (middle post).
Output terminals	Rear panel of 825A, front panel of 825AR	J4, J5	Provided for attaching a recorder to monitor voltage excursions.
Output level control	Rear panel of 825A, front panel of 825AR	R1	Varies the output level of the output binding post from 0 to approximately 20 millivolts full scale deflection.
Meter	Front panel	M1	Indicates approximate voltage when 825A is in VTVM mode and difference between unknown and internal reference voltage when 825A is in differential mode. The upper scale, 500-0-500, is used when the NULL switch is set to VTVM. At all other times, the lower scale, 1-0-1, is used.
Mechanical zero control	Meter case	None	Sets meter to zero mechanically. This adjustment should be used only after instrument has been turned off for at least three minutes or when the meter terminals have been shorted.
Fuse	Rear panel of 825A, front panel of 825AR	F1	Fuse holder protrudes from instrument to provide easy access to the fuse.

Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS. (Sheet 2 of 2)

2-2. ZEROING INSTRUCTIONS

From time to time, it may be necessary to adjust the internal meter zero control. This will normally be done at somewhat more frequent intervals than complete instrument calibration. Proceed as follows:

a. Mechanically zero the meter with the adjustment screw on the front of the meter case. If the instrument is in the case, it must be shut off for at least three minutes prior to this adjustment. If out of case, another method would be to short out the meter terminals prior to zeroing.

b. Set power switch to ON and allow a 20 minute warmup period.

c. Set RANGE switch to 5 or 0.5 volts, voltage readout dials to zero, and NULL switch to 0.001 volt.

d. Adjust R232, VTVM ZERO ADJ, for zero meter deflection. This control may be reached through the ventilation holes in the cabinet model (see figure 4-4). In the rack model, an identified access hole is provided on the rear panel. If the meter cannot be zeroed, clean chopper as outlined in paragraph 4-2c.

2-3. PRELIMINARY OPERATION

The following procedure prepares the voltmeter for operation.

a. Connect power plug to a 115 volt AC power source. If instrument has been wired for 230 volt operation, connect to 230 volts AC

NOTE

The round pin on polarized three-prong plug connects instrument case to power system ground. Use three-to-two pin adapter supplied with instrument when connecting to a two-contact receptacle. For personnel safety, connect short lead to suitable ground.

b. Set controls on 825A voltmeter as follows:

RANGE	500 volts
NULL	VTVM
polarity	+ (positive)
all voltage readout dials	0 (zero)
power	ON

c. After a warmup period of at least ten minutes, advance OPERATE-CALIBRATE switch against spring tension to CALIBRATE, and adjust internal 500 volt DC reference supply with CALIBRATE control for zero meter deflection. Release OPERATE-CALIBRATE switch.

2-4. OPERATION AS A DC DIFFERENTIAL VOLTMETER

a. After completing preliminary operation, connect unknown voltage to input binding posts. If one side is grounded, always connect it to the lower input post (middle post).

b. Turn RANGE switch to lowest range that will allow an on-scale reading and note approximate value of unknown voltage as indicated on upper meter scale.

c. If meter reads to the left, turn polarity switch to the negative position. The meter needle will deflect to the right. This is because polarity of unknown voltage is negative.

d. Noting the position of illuminated decimal light, set five voltage readout dials to approximate voltage determined in step b. For example, if approximate voltage is 35 volts, the decimal light between the B and C voltage readout dials will be illuminated. Therefore, set A dial to 3, B dial to 5, and C, D, and E dials to 0.

e. Set NULL switch to successively more sensitive null ranges, as indicated in figure 2-2, and adjust voltage readout dials for zero meter deflection in each null position. When the meter needle indicates to the right, the voltage under measurement is greater than the voltage set on the voltage readout dials. When the indication is to the left, the voltage is less than that set on the readout dials.

INPUT VOLTAGE RANGE	*RECOMMENDED NULL SETTING
50-500	10 then 1 (then 0.1 for voltages from 50 to 100 volts)
5-50	1 then 0.1 (then 0.01 for voltages from 5 to 10 volts)
0.5-5	0.1 then 0.01 (then 0.001 for voltages from 0.5 to 1 volt)
0-0.5	0.01 then 0.001

*Any null range may be used with any input voltage range; recommended settings are those most useful.

Figure 2-2. RECOMMENDED NULL SETTINGS

f. Read unknown voltage directly from the five voltage readout dials.

2-5. OPERATION AS A CONVENTIONAL VTVM

If it is desired to use the instrument as a VTVM only, additional ranges can be made available by converting the NULL ranges to VTVM ranges. This is made possible by setting the voltage readout dials to zero. Proceed as follows:

a. Perform preliminary operation procedures as stated in paragraph 2-3.

b. Consult figure 2-3, and select full scale voltage deflection desired. If the approximate value of the voltage to be measured is unknown, select the 500 volt range initially.

c. Set RANGE switch, NULL switch, and voltage dials as indicated for the range selected.

d. Connect voltage to be measured to input binding posts. Deflection to the right indicates that unknown DC voltage is of positive polarity.

e. Read voltage from upper or lower scale as listed in figure 2-3.

FULL-SCALE DEFLECTION	RANGE SWITCH	NULL SWITCH	VOLTAGE DIALS	METER SCALE
DC				
500-0-500	500	VTVM	No effect	Upper
50-0-50	50	VTVM	No effect	Upper
5-0-5	5	VTVM	No effect	Upper
0.5-0-0.5	0.5	VTVM	No effect	Upper
10-0-10	No effect	10	All zero	Lower
1-0-1	No effect	1	All zero	Lower
0.1-0-0.1	No effect	0.1	All zero	Lower
0.01-0-0.01	No effect	0.01	All zero	Lower
0.001-0-0.001	No effect	0.001	All zero	Lower

Figure 2-3. VTVM RANGES

2-6. MEASUREMENT OF VOLTAGE EXCURSIONS ABOUT A NOMINAL VALUE

a. Perform preliminary operation as stated in paragraph 2-3.

b. Connect voltage to be observed to input binding posts. If meter reads to the left, the voltage being measured is negative; set polarity switch to the negative position in this case. This will cause meter pointer to deflect to the right.

c. Set RANGE switch to lowest range which will give an on-scale meter indication and note nominal value of voltage indicated.

d. Set the five voltage readout dials to nominal voltage.

e. Turn NULL switch to lowest position that will allow voltage excursions to remain on scale.

f. Read voltage excursions from meter. Note that full scale right and left meter deflections are equal to the NULL voltage setting. Meter deflection to the right indicates that the voltage under observation has increased above the nominal value while deflection to the left indicates it has decreased.

2-7. USE OF 825A WITH A RECORDER

Recorder output binding posts and an output level control are provided on the 825A for monitoring the excursions of an unknown voltage from the voltage indicated by the voltage dial settings. If the leakage resistance between the recorder and ground is less than 10,000 megohms, the accuracy of the 825A will be impaired. Also, both input posts of the recorder should be able to stand 500 volts DC to ground. Therefore, the John Fluke Model A-70 Potentiometric Recorder (manufactured by the Texas Instrument Co.) is recommended for this application. Set up the recorder as follows:

a. Connect A-70 recorder to 825A voltmeter with teflon leads as shown in figure 2-4.

NOTE

Do not ground either of the 825A output terminals or either of the A-70 input terminals. If any of these terminals are grounded, current will be drawn from the 825A Kelvin-Varley divider and the accuracy of the 825A will be completely destroyed.

b. After connecting the recorder, perform preliminary operation as stated in paragraph 2-3.

c. Check for excessive leakage as follows:

(1) Connect a voltage to the input of the 825A and differentially measure its potential.

(2) Alternately connect and disconnect the recorder leads from the output terminals of the 825A while noting the meter needle deflection. More than one-quarter of a small scale division deflection indicates that excessive leakage has been introduced by the recorder. This will impair the accuracy of the 825A voltmeter.

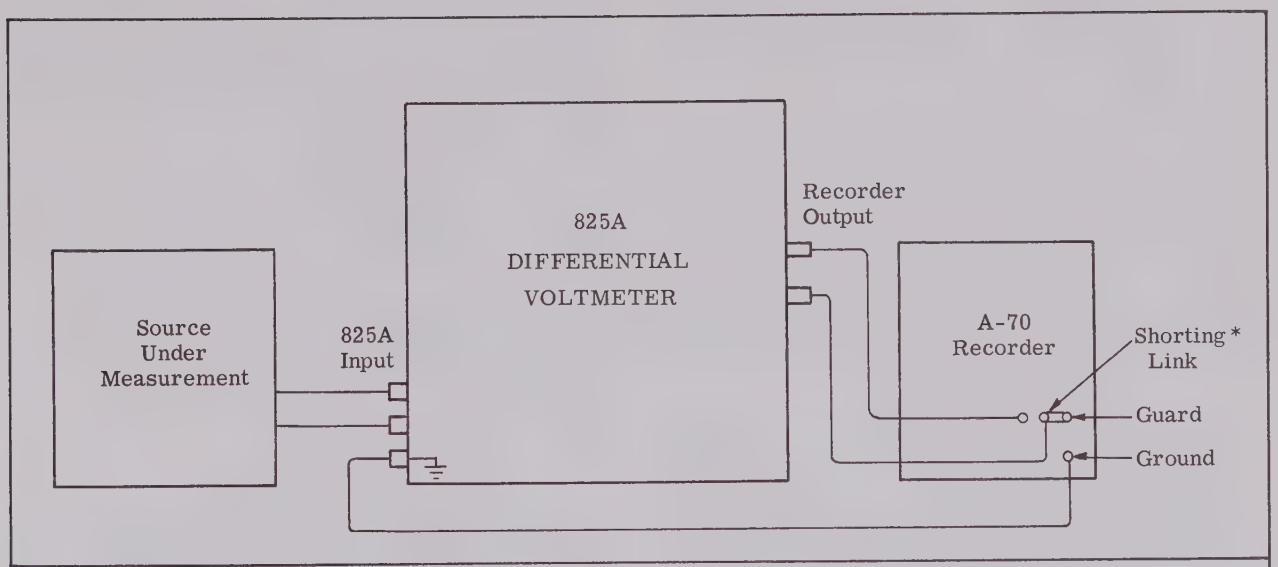
(3) Disconnect the voltage.

d. After the leakage test has been successfully completed, short the input terminals of the 825A.

e. Set switches on the 825A voltmeter as follows:

RANGE	50
NULL	10
voltage readout dials	10.000

The 825A meter will indicate full scale deflection. This provides up to a maximum of approximately 20 millivolts at the output terminals depending on the setting of the output level control.



*If the recorder should be jittery, it is suggested that a 1,000 ohm resistor be substituted for the shorting link.

Figure 2-4. RECORDER RECOMMENDED CONNECTION DIAGRAM

f. Turn the output level control until the recorder deflection obtained is that desired to correspond to full scale deflection of the 825A.

g. Remove the short from the input terminals of the 825A. The 825A and the recorder are now ready for combined use. Proceed as instructed under paragraph 2-6.

2-8. MEASUREMENT OF HIGH RESISTANCES

One of the important features of the 825A voltmeter is its ability to be used as a megohmmeter for rapidly measuring high resistances from 1 megohm to 250,000 megohms. The following equation may be used to compute the resistance in megohms of an unknown connected to the input binding posts:

$$R_x = 10 \left(\frac{E}{E_m} - 1\right) \text{ megohms,}$$

where:

R_x = unknown resistance in megohms

E = voltage indicated by voltage readout dials

E_m = voltage indicated on meter

10 = megohms of input resistance of VTVM circuit on 10, 1, and 0.1 null range.

When connecting the unknown resistance to the input terminals, use short isolated leads to prevent measuring leakage resistance between the leads.

a. FROM 1 MEGOHM TO 500 MEGOHMS. For rapid measurement of resistances from 1 megohm to 500 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 10.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Subtract 10.00 from the amount set on the voltage readout dials to find the resistance of the unknown in megohms.

b. FROM 500 MEGOHMS TO 5000 MEGOHMS. For rapid measurements, of resistances from 500 to 5000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Subtract 1.00 from the amount set on the voltage readout dials and multiply the result by 10 to find the resistance of the unknown in megohms.

c. FROM 5,000 MEGOHMS TO 50,000 MEGOHMS. For rapid measurements, of resistances from 5,000 to 50,000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 0.1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Multiply the amount set on the voltage readout dials by 100 to find the resistance of the unknown in megohms.

d. FROM 50,000 MEGOHMS to 250,000 MEGOHMS. To determine the value of an unknown resistance between 50,000 megohms and 250,000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 0.1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for a convenient meter deflection.

(5) The resistance in megohms may be calculated by substituting the meter reading in volts (E_m, 0 to 0.1 volt on bottom scale) and the voltage readout dial setting (E) into the following equation:

$$R_x = 10 \frac{E}{E_m} \text{ megohms}$$

2-9. NOTES ON MEASURING VOLTAGES

a. ADJUSTMENT OF 500 VOLT SUPPLY. The 500 volt DC reference supply may be adjusted (paragraph 2-3, step c) at any time deemed necessary without heed to the position of the switches and without removing any input or output connections. However, until the instrument has warmed up to an equilibrium temperature (about 1/2 hour), it should be adjusted prior to each specific measurement for best accuracy. When making prolonged measurements, allow one hour warmup time to insure that 500 volt reference supply does not shift during the final warmup phase.

b. GROUND LOOP PRECAUTIONS. Ground loop currents should be avoided to assure accuracy when making measurements. Potential differences are often found at different points on power system grounds. When this is the case, current may flow from the power system ground through the 825A and the equipment under measurement and back to the power system ground. To avoid this when system being measured is grounded, do not connect 825A input binding posts to chassis ground post.

c. USE OF SHORTING LINK. A 0.47 uf capacitor (C1) is connected from the lower input binding post to the chassis ground post to reduce the effect of circulating AC currents from the transformer. In some cases, it is possible for C1 to acquire a charge. For example, C1 will become charged through leakage resistance over a period of time, if there is no external connection to the input terminals and the controls are set as follows: range to 500, null to any null range, polarity to +, and voltage readout dials to several hundred volts. This condition may cause an error on low level measurements (under 5 volts) due to C1 discharging through the Kelvin-Varley divider. Connecting the shorting link from the lower input post to the ground post will discharge C1 and thus prevent an inaccurate indication.

d. RECOMMENDED NULL RANGES. Certain null ranges are recommended for use with each setting of the RANGE switch for the following reasons. With the RANGE switch at 500 volts, the last voltage readout dial (E) changes the reference voltage in steps of 0.01 volt. Therefore, the unknown voltage would have to be an exact multiple of 0.01 volt if a null is to be obtained on the 0.1, 0.01, or 0.001 volt NULL range. Furthermore, it is unlikely that an unknown voltage of a few hundred volts will be stable within 10 millivolts. Finally, the regulation of the reference supply is approximately 0.0025%, or ±0.0125 volt for a 10% change in line voltage. Although this is more than adequate when the instrument is used in the recommended way, a badly fluctuating line voltage may cause the 825A to meter the regulation of its own 500 volt reference supply. For example, when measuring 500 volts, a line change of 10% may cause the 500 volt reference supply to change as much as 12.5 mv. Although this is small, the 825A will indicate full scale for a change as little as 100 mv, 10 mv, or 1 mv if attempting to use the 0.1, 0.01, or 0.001 null ranges.

e. EFFECT OF AC COMPONENTS. An AC component of several times the unknown DC may be present on the unknown and the 825A will always indicate well within the specifications for frequencies over a few hundred cycles. An AC component may have an adverse effect if it is of a low frequency or if it has a frequency that is a multiple or submultiple of the chopper frequency. A double section low pass filter (R201, C201, R202, and C202) is used at the input of the null detector to reduce any AC present on the DC being measured. At lower frequencies, this low pass filter is less effective and the magnitude of the AC component is more significant. If this frequency is below 100 cycles, the accuracy may no longer be with specifications. For example, a 60 cycle AC voltage that is 10% of the input voltage will cause an error of approximately 0.01% which is well within the specifications. Also, since the input attenuation is less for the more sensitive null settings, the accuracy may be affected only on the more sensitive null settings. When the frequency is very close to a multiple or submultiple of the chopper frequency (approximately 94 cycles), the meter needle will oscillate at the difference frequency. If AC components that affect the accuracy are ever encountered, additional filtering will be required. For an AC of a single frequency, a twin-T filter is effective and has the advantage of low total series resistance. For an AC variable frequency, an ordinary low pass filter may be used. In either case, high quality capacitors of high leakage resistance should be used.

f. MEASUREMENT OF NEGATIVE VOLTAGES. Because of a polarity switch, voltages which are negative with respect to ground as well as the more commonly encountered positive voltages may be measured with equal facility. If the upper input post is connected to the metal case, either at the 825A or at the source under measurement, the accuracy of the voltmeter may be reduced. However, with the polarity switch, the upper input post never has to be connected to ground. If the unknown voltage is grounded, always connect the grounded side to the lower input post (middle post) and use the polarity switch to obtain the proper result.

SECTION III

THEORY OF OPERATION

3-1. GENERAL

a. Figure 3-1 shows the block diagram for the 825A Differential Voltmeter. As seen in this figure, the circuit is mainly composed of an input attenuator, a null detector, a Kelvin-Varley divider, a range divider, a 500 volt DC reference power supply, and a null detector power supply. Refer to the functional schematic following Section VI for more detail. This schematic is designed to aid in the understanding of circuit theory and troubleshooting. The signal flow is from left to right and the components are laid out in a functionally logical manner.

b. The overall operation of the voltmeter may be summarized as follows. When used as a conventional VTVM, the unknown voltage is connected directly across the input attenuator. This attenuator is set in such a way that the maximum voltage for each range is reduced to a signal of 1 millivolt. The 1 mv signal is applied to the null detector and causes 100 microamperes to flow through the meter for full scale deflection. When used as a differential voltmeter, the unknown voltage is connected across the series combination of the input attenuator and an internal precision DC voltage. This internal voltage is adjusted by means of the Kelvin-Varley divider until it matches the unknown voltage as indicated by the null detector.

c. In order to provide for a more complete understanding of the 825A voltmeter, the following paragraphs describe each section of the circuit in detail.

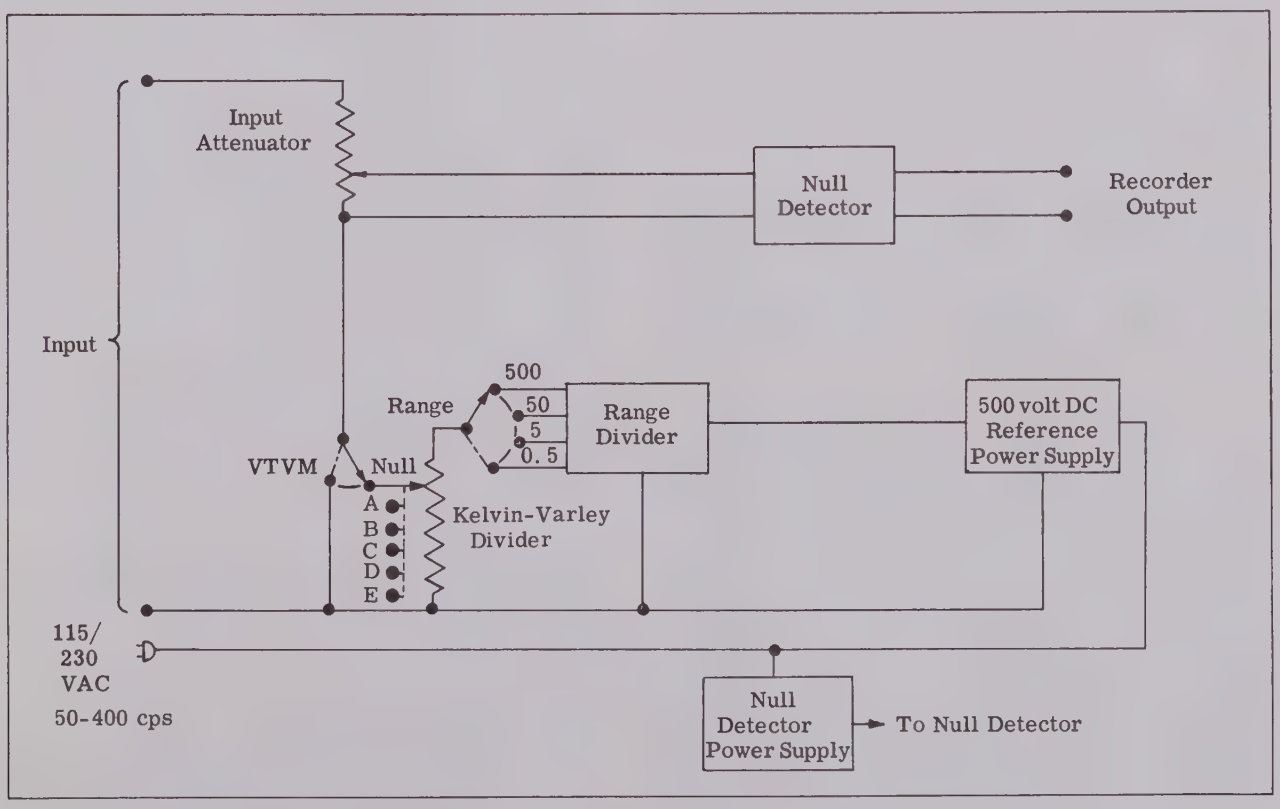


Figure 3-1. 825A DIFFERENTIAL VOLTMETER BLOCK DIAGRAM

3-2. INPUT ATTENUATOR

a. In the VTVM mode, the resistance of the input attenuator and thus the input resistance of the voltmeter is 50 megohms (R301 through R310). For full scale deflection, 1 mv must be applied to the null detector. The necessary reduction is provided by four positions on the input attenuator that are selected by range switch section S2C.

b. In the differential mode, the resistance of the input attenuator is 10 megohms (R305 through R310) for the 10, 1, 0.1, and 0.01 null ranges and 1 megohm (R306 through R310) for the 0.001 volt null range. However, this is not the input resistance of the voltmeter. The input resistance is determined by dividing the terminal voltage of the unknown by the amount of current drawn from the unknown. The current drawn from the unknown is equal to the difference between the unknown terminal voltage and the internally known voltage divided by the resistance of the input attenuator. The equation for input resistance can be hence written as:

$$R_{in} = \frac{E_u}{I_u} = \frac{E_u R_a}{|E_u - E|} = \frac{E_s (R_a + R_s)}{|E_s - E|} - R_s \quad \text{where:}$$

R_{in} = input resistance of voltmeter

E_u = $E_s - I_u R_s$ = terminal voltage of unknown

I_u = current drawn from unknown

E_s = source voltage of unknown

R_s = source resistance of unknown

R_a = resistance of input attenuator

E = voltage indicated by voltage readout dials

$|\ \ |$ = absolute value (magnitude only)

Thus, the input resistance is infinite at null when E is equal to E_u and E_s.

c. For full scale deflection of 10, 1, 0.1, and 0.01 volts, the voltage difference (unknown voltage minus reference voltage) must be reduced by an attenuator. This reduction is provided by four positions on the input attenuator that are selected by null switch section S3D. On the 0.001 volt null range, the voltage across the input attenuator is fed directly to the null detector.

3-3. NULL DETECTOR

a. GENERAL. The null detector is a fixed gain device containing four resistance-capacitance coupled voltage amplifier stages with a high amount of negative current feedback. With high negative current feedback, the output current is approximately equal to the signal voltage divided by the impedance of the feedback network regardless of the amplifier characteristics or even the load impedance. The high negative feedback also makes the amplifier relatively insensitive to the gain changes in individual tubes due to aging and replacement. The output current from the null detector is indicated on a meter that has taut-band suspension. This suspension does away with all friction associated with meter pivot stickiness. Thus, any tendency for the meter pointer to stick at one point of the scale and then jump to another point is completely eliminated.

b. OPERATION. At the input to the null detector, R201, C201, R202, and C202 form a double section low pass filter that reduces any AC component present on the DC voltage being measured. The difference between the voltage appearing at the output of the filter and the voltage developed across the feedback network is converted to an alternating voltage by G1, a 94 cycle chopper This chopped voltage is amplified by V202A, V202B, and V203A before passing through cathode follower V203B. During half the chopper cycle the output of the amplifier is clamped to approximate null detector common potential by G1 while during the other half the output is filtered by C212 to provide a DC current for the meter. When the chopper provides connection between contacts 1 and 9, a voltage is developed across feedback network R220, R221, and R222 that is proportional to the meter (output) current. This feedback voltage reduces the filter output voltage with respect to the four stage amplifier. The impedance of the feedback network (R220, R221, and R222) is adjustable between 8.82 and 9.83 ohms. Since the output current is approximately equal to the signal voltage divided by the impedance of the feedback network, a 1 mv signal voltage indicates an output current of 101.7 to 113.4 ua. However, there is a loss due to finite amplifier gain and filtering that leaves the output current around 100 ua which can be set accurately by means of the feedback network. Thus, current feedback makes the output current essentially proportional to the signal voltage. For full scale deflection, a 1 mv signal voltage will cause 100 ua to flow through the meter.

c. EFFECT OF AC COMPONENTS. The only AC voltage component that will reduce the accuracy of the 825A is one that either saturates the chopper-amplifier or one that beats with the chopper frequency. Since the voltage required for saturation is greater than that required for beating, the null detector is most sensitive to an AC component with a frequency that is a submultiple or a low multiple of the chopper frequency. However, this is easy to detect because the meter will beat at the difference frequency The low pass filter at the input of the chopper-amplifier will attenuate any AC component. The magnitude of the AC voltage appearing at the output of the filter depends on both its amplitude and frequency before filtering. For all practical purposes, one should never encounter any trouble above a few hundred cycles. Below this, the filter may not attenuate the AC component enough. However, this is not as bad as it appears. A 60 cycle AC voltage that is 10% of the input voltage will cause an error of approximately 0.01% which is well within specifications. If AC components that affect accuracy are ever encountered, additional filtering as set forth in paragraph 2-9 will eliminate the problem.

d. ADJUSTMENTS. Variable resistor R232 in the null detector power supply provides a means of adjusting the output current of the amplifier to zero when there is no input signal. The gain of the amplifier is adjusted by means of R222 in the feedback circuit.

e. RECORDER OUTPUT. The recorder output is picked off divider string R225, R1, and R226. Output level control R1 provides a means of adjusting the output voltage up to a maximum of approximately 20 millivolts at full scale deflection. The voltage at the output terminals is proportional to the meter reading.

3-4. 500 VDC REFERENCE POWER SUPPLY

a. When the 825A is used for differential voltage measurements, an internal DC voltage is nulled or matched against the unknown voltage. An extremely accurate reference voltage is therefore required. This is obtained from the 500 volt DC reference supply

b. A half wave rectifier system consisting of three diodes (CR101, CR102, and CR103) and a filter network (R105, R106, C101, and C102) supply unregulated DC voltage to series passing tube V102. The voltage is regulated by comparing the voltage from reference tube V104 with a voltage tapped off a divider string (R119, R120, R121, and R2) in a differential amplifier V105. The output of differential amplifier V105 is fed to differential amplifier V106 which drives the grid of series passing tube V102. In this way the voltage drop across the passing tube is controlled such that the reference supply is maintained at 500 (±0.005) volts.

c. With RANGE switch set to 500, sections S2B and S2F (just S2F before serial number 185 on 825A and serial number 144 on 825AR) connect 500 volts directly to the Kelvin-Varley divider. In the 50, 5, and 0.5 volt positions, range resistors controlled by S2E divide the reference voltage to 50, 5, and 0.5 volts. These voltages are switched to the Kelvin-Varley divider by S2F. The 50, 5, and 0.5 range resistors networks are set accurately during calibration by means of R323, R326, and R329.

d. Variable resistor R121 is used during calibration to set the reference supply to 500 volts with CALIBRATE control (R2) set at its center of rotation. This allows the reference supply to be adjusted to 500 volts by means of the CALIBRATE control at any time deemed necessary. With the OPERATE-CALIBRATE switch held at CALIBRATE, a fixed percentage of the reference supply is compared to the precise potential of an internal standard cell or Zener diode (in the/AG models). Any difference in potential is fed to the null detector so that the reference supply can be set with the CALIBRATE control. The fixed percentage of the reference supply is set accurately during calibration by means of R318.

e. For proper operation a highly stable and accurate balance of amplification must be maintained between the two halves of differential amplifier V105. The filament supply for V105 must be regulated to maintain this balance. In earlier models, regulation was provided by ballast tube V101 which supplied a constant current to the filament of V105. Thus, the ballast tube absorbed any secondary winding voltage changes caused by line fluctuations. In later models, a transistor regulator is used to provide even better regulation than could be obtained by using a ballast tube A filtered half-wave rectifier (CR104 and C106) drives a Darlington connection of Q1 and Q2. A divider string, R101 and R102, uses the plate of V104 to maintain approximately 6.3 volts on pin-9 of V105 while pin-4 and pin-5 are maintained at approximately 0 volts through the emitter-base junctions of Q101 and Q102. Thus any change in the half-wave rectifier voltage causes a corresponding change in the voltage across the emitter collector junction of Q101 so that the filament voltage of V105 remains stable.

3.5. KELVIN-VARLEY DIVIDER

a. In order to null unknown voltages, each one of the four precision voltages available from the reference supply must be made adjustable. The five Kelvin-Varley decade resistor strings, R401 through R449 accomplish this function.

b. Note that each string, with the exception of the first, parallels two resistors of the string that preceeds it. Between the two wipers of S6 (voltage dial A) then, there is a total resistance of 40K (80K paralleled by 80K). With the RANGE switch in the 500 volt position, a total voltage of 100 volts DC will appear across these two wipers. Also, there will be 10, 1, and 0.1 volts DC across the wipers of S7, S8, and S9 respectively. Voltage dial E (S10) picks increments of 0.01 volts DC from the last decade. These voltages are reduced by a factor of 10 for each lower voltage range.

c. All the resistors of each decade are matched and all decades are matched for each instrument, providing an overall divider accuracy of 0.005% absolute.

d. With the NULL switch in any null range, the output of the Kelvin-Varley divider is connected in series with the input attenuator as seen from the input terminals.

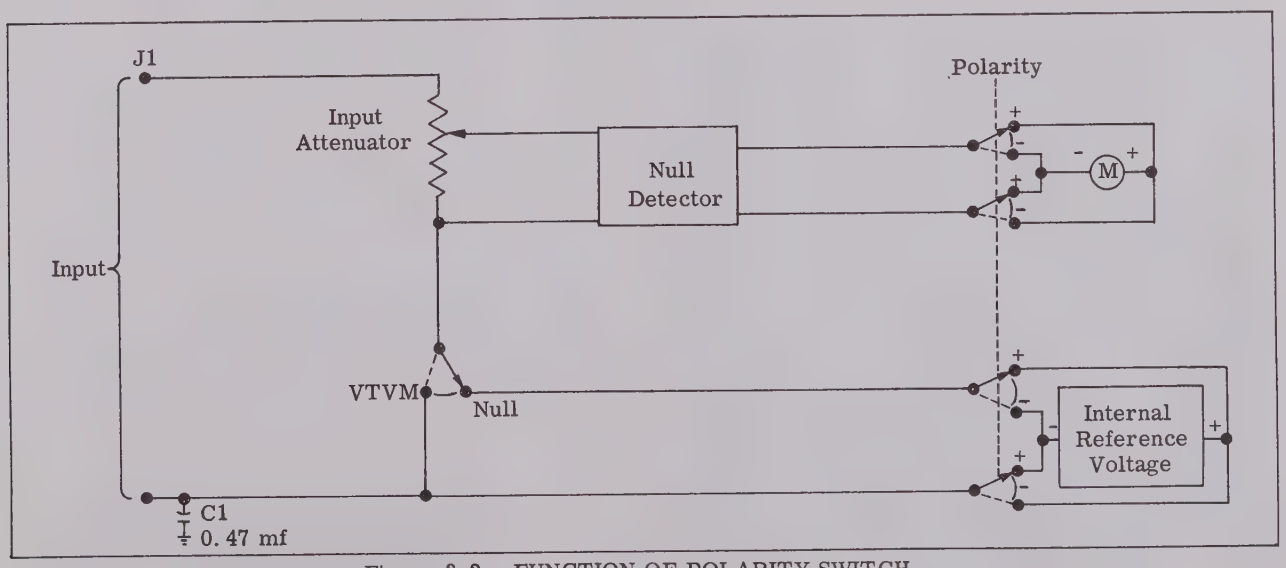


Figure 3-2. FUNCTION OF POLARITY SWITCH

Also, the null detector operates with a common that is above or below (depending on the setting of the polarity switch) the potential of the lower input binding post by the amount set on the voltage readout dials.

3-6. POLARITY SWITCH

Because of the polarity switch S5, upper input post J1 should never be electrically connected to the 825A chassis, either at the 825A or at the source under measurement. As seen in figure 3-2, the polarity switch does not just reverse the input posts. It reverses the meter and the internal reference supply. If the instrument did not contain a polarity switch, the grounded side of any unknown voltage that is negative with respect to ground would have to be connected to the upper input binding post. This would ground the upper post and effectively place C1 (a 0.47 uf capacitor) across the input terminals. Even if C1 was disconnected, there would still be considerable capacitance across the input due to transformer winding capacitance and stray wiring capacitance. With this capacitance across the circuit being measured several problems would arise. The polarity switch provides equal convenience in measuring positive or negative voltages without the occurance of these problems.

3-7. NULL DETECTOR POWER SUPPLY

a. The B+ supply for the null detector is obtained from a half-wave rectifier consisting of diode CR201 and a filter network (C213A, R227, and C213B) that is regulated by an 0A2 tube (V204) and series dropping resistor R230. Divider resistors R228, R229, R231, and R232 and diode CR202 provide a compensating voltage for the purpose of adjusting the null detector to zero with R232 when there is no signal input. Diode CR202 keeps one, side of R232 at approximately-0.6 volts DC with respect to the null detector common.

b. The filament of V202 and the chopper drive unit require a stable supply. This is obtained by using a filtered half-wave rectifier (CR203 and C214) that drives a Darlington connection of Q1 and Q2. A divider string R234 and R235 uses the B+ supply to obtain approximately 11.8 volts for pin-5 of V202 while pin-4 is maintained approximately 0 volts through the emitter-base junctions of Q201 and Q202. Any change in the half-wave rectifier voltage causes a corresponding change in the voltage across the emitter-collector junction of Q201 so that the filament and chopper voltage remain stable. The filament supply for V203 is obtained from an ordinary 6.3 volt AC winding.

SECTION IV

MAINTENANCE

4-1. GENERAL

The 825A Differential DC Voltmeter seldom requires any maintenance. Without extreme abuse, all that should be required is occasional cleaning, tube replacement, and calibration. Preventive maintenance consists only of preventing contamination of the chopper contacts and any leakage as discussed in paragraph 4-2. A discussion of troubleshooting along with a troubleshooting chart, component location diagrams, and a tube voltage chart are provided in paragraph 4-3. Paragraph 4-4 delineates the equipment and procedures necessary to calibrate the instrument.

4-2. PREVENTIVE MAINTENANCE

a. LEAKAGE PREVENTION. The accuracy of the 825A is adversely affected by excessive electrical leakage from the input of the null detector to either ground or the 500 volt reference supply. This leakage becomes evident when the RANGE switch is set to 500, NULL switch to 0.1, voltage readout dials to 490.00, and no input at the binding posts. The leakage indicated on the meter should be not more than one-tenth of full scale. Special care has been taken to prevent leakage across certain critical switch wafers and areas of some printed circuit boards due to moisture from condensation. The printed circuit boards and sensitive areas of the null detector chassis have been coated with Humi-Seal 1B12 (manufactured by Columbia Technical Corp. of Woodside, New York). The RANGE, NULL, OPERATE-CALIBRATE, and polarity switches have been dipped in Dow Corning silicone oil. Accumulations of dust and foreign matter will cause internal leakage, and should be removed as often as necessary, depending on environmental operating conditions. Blowing the instrument out with low pressure, clean, dry air will remove most accumulations. Particular attention should be paid to the binding posts and wiring, the NULL, RANGE, OPERATE-CALIBRATE, and polarity switches, and the two glass epoxy strips which insulate the null detector chassis from the main chassis.

b. After blowing the instrument out, wipe the glass epoxy strips with a clean dry rag. If necessary use a rag saturated in anhydrous denatured ethyl alcohol. The binding posts, insulators, and front panel may also be cleaned with denatured alcohol. When necessary, wash all exposed dielectric surfaces of the NULL, RANGE, OPERATE-CALIBRATE, and polarity switch with this alcohol using a small, stiff-bristled brush.

CAUTION

Do not use Metriclene, acetone, lacquer thinner, or any other methyl ethyl ketones since they will react with the Lexan rotor on the CTS plastic switches.

After washing, recoat the switch insulating material with a solution of Dow Corning 200 having a viscosity between 5 and 20 centistokes. This prevents leakage due to moisture on these surfaces.

c. CHOPPER CLEANING. All electromechanical choppers accumulate some foreign matter on the contacts over a period of time. This contact contamination only presents a problem in low level amplifiers of the type used in the 825A. It can cause the zero to shift to such an extent that the null detector can no longer be zeroed with VTVM ZERO ADJ control R232. To clean the chopper contacts, proceed as follows:

(1) On cabinet models, remove screws at back of cabinet and slide instrument out of case. On rack models, remove screws holding cover to instrument and set cover aside.

(2) Remove chopper from null detector chassis assembly and unplug chopper drive unit.

(3) Remove two screws at top of chopper and slide cover off.

CAUTION

Never touch the chopper contacts. It is also good practice not to handle any interior parts.

(4) Immerse chopper in clean denatured alcohol until the contacts are just under the surface (figure 4-1) and then agitate the chopper for about a minute.

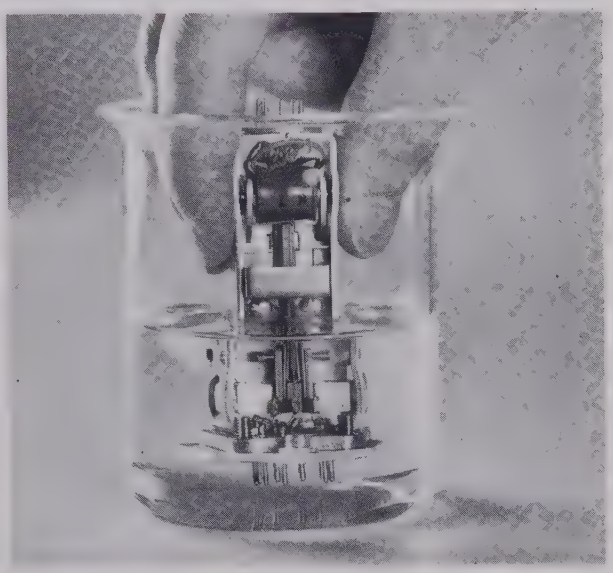


Figure 4-1. CHOPPER CLEANING

(5) After chopper is thoroughly dry, replace chopper cover and install in instrument.

NOTE

If the chopper drive unit is unplugged while the instrument is on, the chopper drive unit will not operate when reassembled. However, the chopper drive unit will operate if the instrument is turned off and then turned back on.

(6) Adjust VTVM ZERO ADJ control R232 for zero meter deflection after a 20 minute warmup period.

4-3. TROUBLESHOOTING

a. GENERAL. To assist in localizing most troubles which might occur, a troubleshooting chart (figure 4-2) lists the causes and remedies for a number of symptoms. Since failure of the 825A is usually due to tube failure, it is recommended that tube substitution be tried before any other tests are made. However, the 825A is conservatively designed and should require very infrequent tube replacement. At certain times, a check of the DC pin voltages in the tubes (figure 4-6) is also useful. As an aid to troubleshooting, all components may be located by referring to the figures shown in Section V. An understanding of the theory of operation (Section III) and frequent reference to the functional schematic will be of great value in troubleshooting.

SYMPTOM	PROBABLE CAUSE	REMEDY
Drift of the 500 volt DC reference supply evidenced by the continual need for resetting with the CALIBRATE control.	V104, V105, or V106 defective.	Check V104, V105, and V106 by replacement.
	One of the sampling string resistors (R119, R120, R121) is changing value rapidly as the instrument warms up.	Locate faulty resistor by heating slightly with a soldering iron held near the resistor while observing the 500 volt DC calibration.
	Drifting standard cell EMF possibly caused by previous shorting or inverting of the cell (825A and 825AR only).	Allow time for the standard cell to stabilize. Several hours should be sufficient.
Cannot calibrate 500 volt DC reference supply.	Excessive aging of V105.	Check V104 by replacement.
Meter cannot be brought to zero with CALIBRATE control.	Out of calibration.	Recalibrate per paragraph 4-4.
	One or more resistors in 500 volt DC sampling string has shifted in value.	Recalibrate per paragraph 4-4 and observe stability for 48 hours. If 500 volt DC reference supply remains stable replacement of resistor is unnecessary.
	Standard cell EMF has shifted (825A and 825AR only).	Recalibrate instrument and observe stability of reference supply. Replacement of the standard cell may be necessary.
Measurements are out of tolerance on one range other than the 500 volt range.	A reference supply output range resistor on the range resistor printed circuit board is out of tolerance.	If the trouble occurs in the 50 volt range, R324 has shifted; in the 5 volt range, R325 or R327 has shifted; in the 0.5 volt range, R328 or R330 has shifted. It may be possible to correct by recalibration. If not, replace faulty resistor.
Measurements are out of tolerance on all ranges other than the 500 volt range.	R320 or R321 has shifted in value.	It may be possible to correct all range voltages by recalibration. If not, replace faulty resistor.

Figure 4-2. TROUBLESHOOTING (Sheet 1 of 2)

SYMPTOM	PROBABLE CAUSE	REMEDY
Measurements are out of tolerance on any range when the Kelvin-Varley divider is dialed to any setting other than 499910.	One of the Kelvin-Varley divider resistors is out of tolerance.	Measure the voltage drop across each Kelvin-Varley resistor with another John Fluke Differential Voltmeter. Begin by setting RANGE switch to 500 volts and the voltage readout dials to 499.910. Reference to the schematic diagram will show that there should be 100, 10, 1, 0.1, and 0.01 volts respectively across each resistor of the A, B, C, D, and E decades, except for the two resistors of each decade that are paralleled by the following decade. Across these two resistors, there should be 50, 0.5, and 0.05 volts, respectively. Measure all voltages ±0.05%. Remember that if one resistor in a decade has increased or decreased appreciably, the voltage drop across all other resistors in the decade will be slightly affected also.
Instrument is out of specifications on all ranges.	Resistors R306, R307, R308 or R309 out of tolerance.	Check and replace faulty resistor.
Meter rattle, drift, or error is observed on all null ranges.	V202, V203, or V204 faulty. Chopper G1 faulty. Moisture or dirt on printed circuit boards or switches.	Check V202, V203, and V204 by replacement. Clean or replace chopper. Clean instrument.

Figure 4-2. TROUBLESHOOTING (Sheet 2 of 2)

b. TUBE REPLACEMENT. Replacement of tubes will not normally necessitate complete recalibration of the 825A. If V202 or V203 is replaced, calibrate the null detector as set forth in paragraphs 4-4b and 4-4c. Replacement of V102, V104, V105, or V106 will necessitate calibration of the reference supply per paragraphs 4-4b and 4-4d.

c. COMPONENT REPLACEMENT. Should it ever become necessary to replace a component on a printed circuit board or on the null detector chassis, proceed as follows:

(1) Clean soldered area around component with Methyl Ethyl Keytone.

(2) Remove part and install new component.

(3) Remove flux with du Pont Freon PC.

(4) Allow to dry for 10 minutes. When it is cool or humid, it may be necessary to place area under a lamp to ensure thorough drying.

(5) Coat any uncoated areas around R305 through R310 on the Range Resistor Printed Circuit Board and around the input to the null detector chassis (tube V202, 5751, and chopper) with Humi-Seal 1B12.

d. STANDARD CELL PROBLEMS. The standard cell in the Model 825A and 825AR deserves special consideration if it is suspected of being faulty:

(1) The standard cell used in the 825A and 825AR is a miniature low hysteresis unit which has excellent long term stability and negligible temperature hysteresis. (Hysteresis is a temporary increase in EMF immediately following a decrease in temperature; this effect should not be confused with temperature coefficient.) Under normal conditions this cell should last from 8 to 15 years. In rare instances, failure has occurred in less than 2 years. End of life is usually marked by an increase in temperature hysteresis effect. That is, reading errors in excess of 0.025% will result when the same voltage is read with the 825A hot and cold. Should replacement of the cell become necessary for any reason, the instrument must be recalibrated (basic 500 volt range only), since the EMF of different cells may be different by as much as 0.05% and each instrument is calibrated to its own particular standard cell. Refer to the recalibration instructions in this case.

(2) Failure of the standard cell may occur if subjected to below freezing temperature. The electrolyte will freeze at 1°F and operation below 32°F is definitely not recommended. The life of the cell also will be greater if the 825A is not operated at elevated temperatures. The 8 to 15 year figure holds for operation of the instrument in normal room temperature.

(3) The EMF of the standard cell will change if the cell has been inverted, or if the cell has been inadvertently short-circuited. If the EMF has changed, the 825A will naturally be out of calibration on all ranges. In either case, the cell will return to its original EMF. If the cell were inverted or shorted for only a few seconds, the 825A should be able to measure voltages within specifications after several hours recovery time.

e. DECIMAL LAMP REPLACEMENT. The decimal lamps are normal 6.3 volt pilot bulbs. To prolong their life these bulbs are operated from a 5 volt transformer winding. However, these bulbs do occasionally fail. To replace, proceed as follows:

(1) On cabinet models, remove screws at back of cabinet and slide instrument out of case.

(2) Remove four screws that hold front panel assembly to chassis.

(3) Being careful to avoid wiring damage, gently lift front panel assembly from instrument and set face down in front of instrument.

(4) Remove screws holding range resistor printed circuit board and Kelvin-Varley printed circuit board to front panel assembly.

(5) Push these printed circuit boards aside enough to allow access to pilot light holders.

(6) Remove pilot light holder from bracket by applying pressure to each side of holder.

(7) Remove cardboard light shield and replace pilot light.

(8) On rack models, remove screws holding cover to instrument and set cover aside.

(9) Remove pilot light holder from bracket by applying pressure to each side of holder.

(10) Remove cardboard light shield and replace pilot light.

4-4. CALIBRATION

a. GENERAL. The 825A can be calibrated as often as deemed necessary. However, it is recommended that the Zener diode models be calibrated every 45 days and standard cell models every 90 days. For special applications where extreme accuracy is required, it may be desired to calibrate the instrument more frequently. Calibration should be accomplished in a draft-free area with ambient temperature of 72 (±3) °F for maximum accuracy under typical laboratory operating conditions. Figure 4-3 lists the type of test equipment required for calibration along with the applicable specifications and recommended instruments. All controls may be located with the aid of figure 4-4 and 4-5. The recommended calibration set-up is shown in figure 4-7. While the Bureau of Standards will certify the Eppley 100 cell to only 0.01%, it may be maintained to 0.002% if treated with care and not subjected to sudden temperature

RECOMMENDED EQUIPMENT	SPECIFICATIONS REQUIRED
Any Fluke Model 800 series voltmeter. Fluke 301C or 301E Power Supply Eppley Standard Cell 100A Leeds and Northrup 2430A Galvanometer Electro Scientific Industries Special Precision Voltage Divider X194 Any single pole push button switch with fine silver contacts Any double pole push button switch with fine silver contacts Any 5.6 (±10%) Ω resistor Any 56 (±10%) Ω resistor	The equipment used must provide 500, 50, 5, and 0.5 volts with an accuracy of 0.01%.

Figure 4-3. CALIBRATION EQUIPMENT

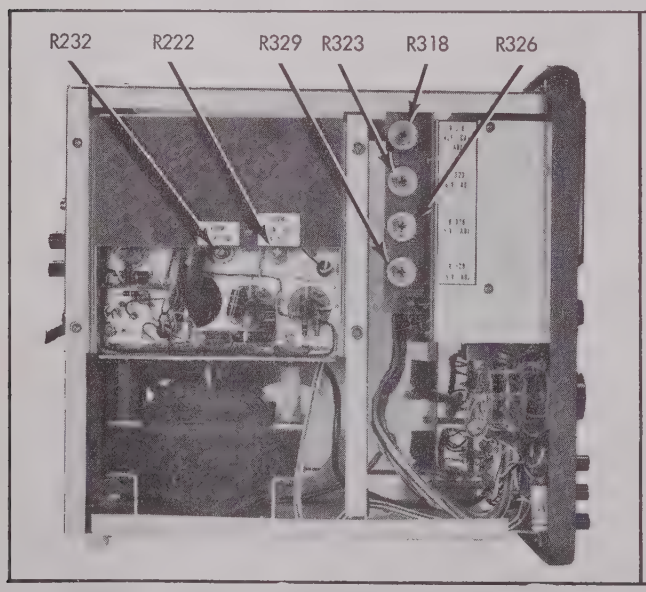


Figure 4-4. ADJUSTMENT LOCATIONS

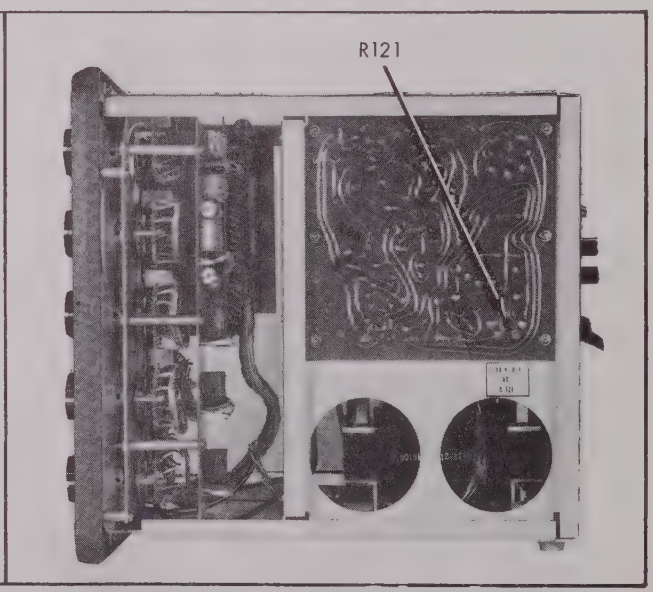


Figure 4-5. ADJUSTMENT LOCATIONS

Symbol & Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V102, 6BQ5	No Conn.	495	500	Heater voltage 6.3 volts ac		No Conn.	680 to 730	No Conn	680 to 730
V104, OG3	85	0	Int. Conn.	0	85	Int. Conn.	0	No Pin	No Pin
V105, 12AX7	217	84	86	Heater voltage 6.0 volts dc		217	84	86	See Pin 4 & 5
V106, 12AX7	495	217	220	Heater voltage 6.3 volts ac		500	217	220	
V202, 5751	60	-	0	Heater voltage 12 volts dc		100	-	1.5	No Conn.
V203, 6AW8	47	45	140	Heater voltage 6.3 volts ac		0.7	-	25	50
V204, OA2	150	0	Int. Conn.	0	150	Int. Conn.	0	No Pin	No Pin

This chart is to be used under the following conditions: (a) RANGE switch set to 500; (b) NULL switch set to VTVM: (c) all voltage readout dials set to zero; (d) line voltage at 115/230 volts, 50 - 400 cycles; and (e) all measurements made with a VTVM from negative binding post to specified terminal.

Figure 4-6. TUBE VOLTAGE CHART

changes. For reasonable certainty of 0.002% cell accuracy, the certified value should be known to six places. Since the ESI voltage divider is accurate within ±0.005%, the overall calibration system accuracy is between 0.003% and 0.007%.

b. PRELIMINARY CALIBRATION PROCEDURES

(1) Set 825A meter to zero with mechanical zero control.

(2) Set switches on 825A as follows:

RANGE	500
NULL	VTVM
polarity	+ (positive)
all voltage readout dials	0 (zero)

(3) Place 825A and all calibration test equipment in operation.

(4) Allow all equipment to warm up until it reaches equilibrium temperature (about 1/2 hour).

(5) Set up the necessary equipment to provide DC voltages of 500, 50, 5, and 0.5 V DC with an accuracy of at least 0.01%. The recommended equipment and method of connection is shown in figure 4-7.

(6) Set the proper standard cell voltage on the ESI divider.

(7) Apply 500 volts DC into the divider from a Model 301C or 301E power supply.

(8) Set ESI divider to 500 and zero galvanometer by varying the output of the power supply while depressing the coarse and then the coarse and fine push-button switches. Voltages of 500, 50, 5, and 0.5 volts DC (±0.01%) are made available at the output posts by merely changing the position of the voltage selector switch on the voltage divider.

c. NULL DETECTOR CALIBRATION

(1) Connect chassis ground to line ground.

(2) Short meter terminals and zero meter with adjustment screw on the front of meter case.

(3) Adjust VTVM ZERO ADJ control R232 until 825A meter indicates zero. If meter cannot be zeroed, clean chopper as outlined in paragraph 4-2c.

(4) Apply 500 volts DC to voltmeter.

(5) Adjust VTVM GAIN ADJ control R222 for full scale deflection.

d. 500 V DC REFERENCE SUPPLY CALIBRATION

(1) Measure reference supply voltage between pin-3 of V102 and negative binding posts.

(2) Center CALIBRATE control at its center of rotation.

(3) Adjust 500 V REF ADJ control R121 until reference supply is 500.0 (±0.2 volts).

e. 500 V DC REFERENCE SUPPLY ADJUSTMENT

(1) Set switches on 825A as follows:

RANGE	500
NULL	0.1
Voltage readout dials	499.910

(2) Apply 500 volts DC (±0.01%) to voltmeter.

(3) Null 825A meter by adjusting CALIBRATE control.

(4) Advance OPERATE-CALIBRATE switch against spring tension to CALIBRATE and null meter by adjusting REF-CAL ADJ control R318.

f. 50 V DC RANGE DIVIDER CALIBRATION

(1) Set switches on 825A as follows:

RANGE	50
NULL	0.01
Voltage read-out dials	49.9910

(2) Apply 50 volts DC (±0.01%) to voltmeter.

(3) Null 825A meter by adjusting 50 V ADJ control R323.

g. 5 V DC RANGE DIVIDER CALIBRATION

(1) Set switches on 825A as follows:

RANGE	5
NULL	0.001
Voltage read-out dials	4.99910

(2) Apply 5 volts DC (±0.01%) to voltmeter.

(3) Null 825A meter by adjusting 5 V ADJ control R326.

h. 0.5 V DC RANGE DIVIDER CALIBRATION

(1) Set switches on 825A as follows:

RANGE	0.5
NULL	0.001
Voltage read-out dials	.499910

(2) Apply 0.5 volts DC (±0.01%) to voltmeter.

(3) Null 825A meter by adjusting .5 V ADJ control R329.

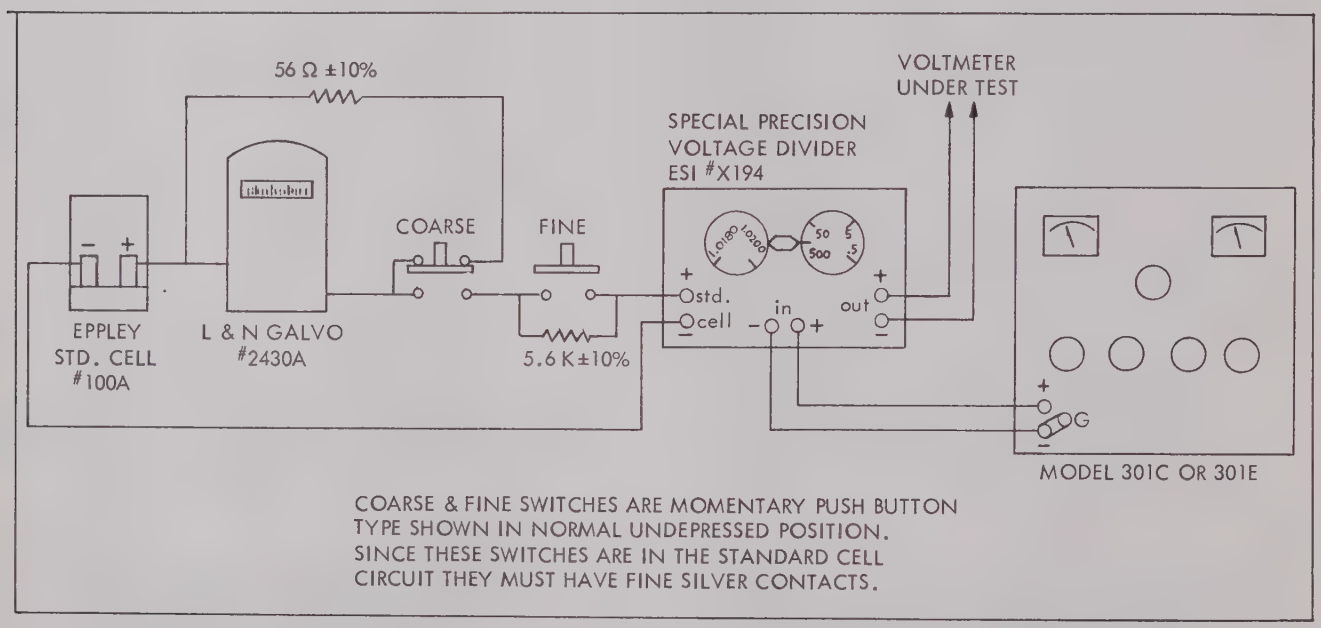

56 Ω ±10%
VOLTMETER UNDER TEST
SPECIAL PRECISION VOLTAGE DIVIDER ESI #X194
COARSE
FINE
EPPLEY STD. CELL #100A
L & N GALVO #2430A
5.6 K±10%
std. cell
in
out
G
MODEL 301C OR 301E
COARSE & FINE SWITCHES ARE MOMENTARY PUSH BUTTON TYPE SHOWN IN NORMAL UNDEPRESSED POSITION. SINCE THESE SWITCHES ARE IN THE STANDARD CELL CIRCUIT THEY MUST HAVE FINE SILVER CONTACTS.

Figure 4-7. CALIBRATION CONNECTION DIAGRAM

SECTION V

LIST OF REPLACEABLE PARTS

5-1. GENERAL

a. The following six assembly lists describe all normally replaceable parts of the Model 825A, 825AR, 825A/AG, and 825AR/AG Differential DC Voltmeters. Each list has a corresponding illustration on which the parts for that list are pointed out. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke stock number.

b. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the 825A. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section.

5-2. HOW TO OBTAIN PARTS

a. Standard components have been used whenever possible. Thus, most parts may be obtained locally. However, special components are used in some instances. All parts manufactured or altered by Fluke and all parts for which Fluke controls the design are designated by an asterisk preceding the Fluke stock number. All structural parts and special parts should be purchased from your local Fluke representative or from the factory.

b. When ordering parts always include:

(1) Reference designation, description, and Fluke stock number.

(2) Instrument model and serial number.

(3) Most structural parts are not listed. In this case, give complete description, function, and location for the part.

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Final Assembly (Cabinet model, standard cell option)	*825A-501	
	(Rack model, standard cell option)	*825AR-502	
	(Cabinet model, Zener diode option)	*825A/AG-503	
	(Rack model, Zener diode option)	*825AR/AG-504	
	Front Panel Assembly (See figure 5-2)	*825A-404	
		*825AR-410	
		*825A/G-413	
		*825AR/G-416	
J4, J5	Rear Chassis		
	Binding post, black	X219	I
	Binding post insulator, dual, black (2 used)	801B-830	H
	Binding post insulator, red (4 used)	X217	G
	Binding post, red	X2231	J
C2	Capacitor, electrolytic, 15 uf, -10/+150%, 6V	CE36	E
CR1, CR2	Diode, silicon, 300 ma, 400 PIV	2E4	E
F1	Fuse, 1 ampere, slow-blowing (for 115 volt operation)	F1A	
	Fuse, 1/2 ampere, slow-blowing (for 230 volt operation)	F-1/2B	
R1	Resistor, variable wirewound 10K, 10%, 2W	P10KA	
	Null Detector Chassis Assembly (See figure 5-4)	*825A-408	
	Range Resistor Printed Circuit Board Assembly (See figure 5-5)	*825A-405	
		*825AR-421	
		*825A/G-406	
		*825AR/G-424	
R3	Resistor, precision power (825A/AG and 825AR/AG. Optimum value is selected at factory to match Zener diode. When ordering, include date and serial number listed on Range Resistor Printed Circuit Board.)		
	Reference Supply Printed Circuit Board Assembly (See figure 5-3)	*801B-401	C
		*801B-423	D
	Kelvin-Varley Resistor Printed Circuit Board Assembly (See figure 5-6)	*801B-403	
	Transformer, power	*801B-651	C
		*801B-652	D

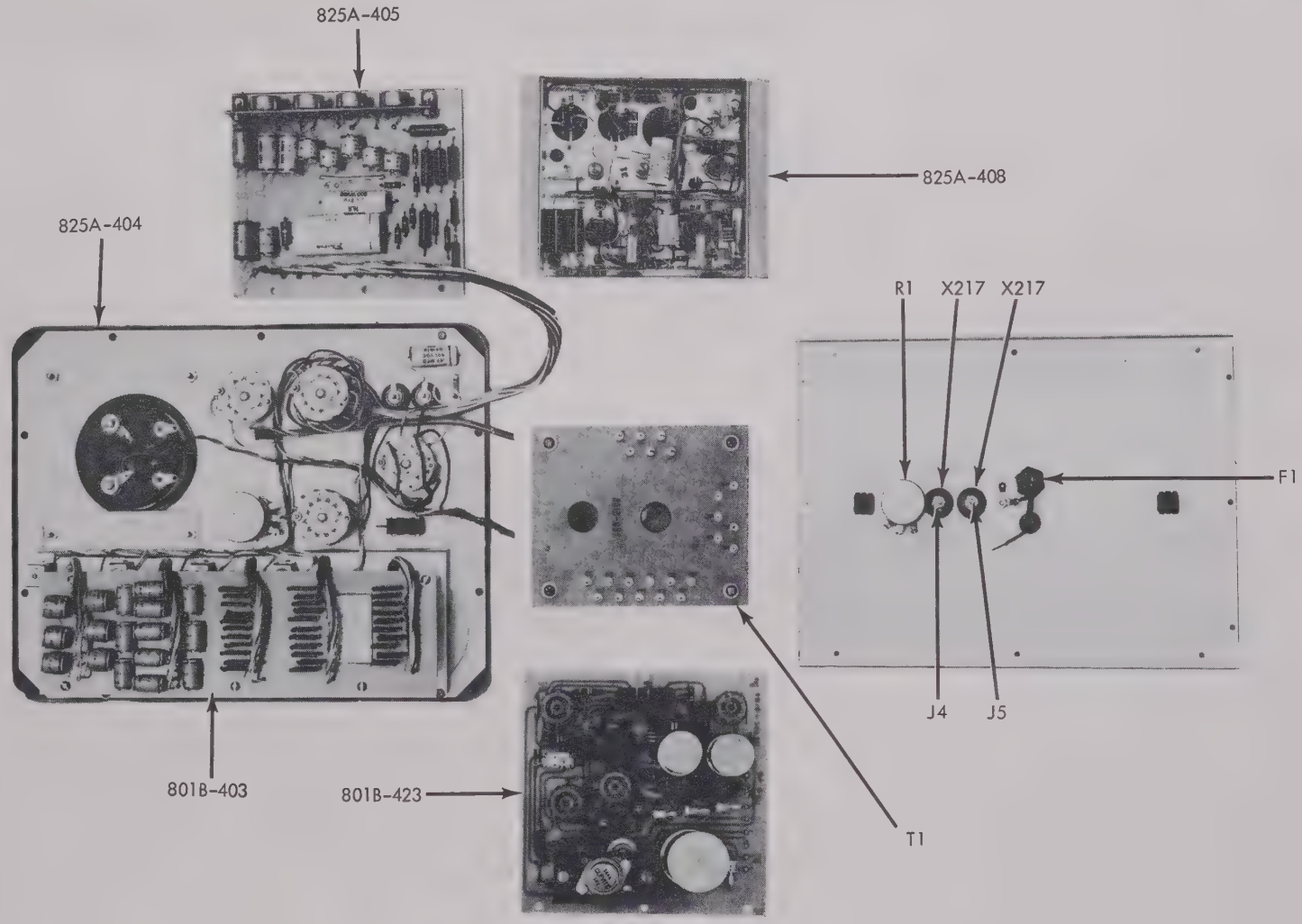


Figure 5-1. FINAL ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Front Panel Assembly	*825A-404 *825AR-410 *825A/G-413 *825AR/G-416	
J1, J2, J3	Binding post, black	X219	G
J2	Binding post, black	X219	H
J1, J3	Binding post, red	X2231	H
	Binding post insulator, red (4 used)	X217	G
	Binding post insulator, dual, black (2 used)	801B-803	H
	Binding post spacer	X220	
	Knob, 1 inch with pointer	X231	
	Knob, 1-1/2 inch without pointer	X207	
	Knob, 1-1/2 inch with pointer	X234	
	Knob, 1 inch without pointer	X2047	
	Voltage dial plates (cabinet model) (rack model)	D3 D2	
B1	Standard cell (825A and 825AR)	X223	
C1	Capacitor, mylar, 0.47 uf, 10%, 600V	CP25	
M1	Meter, 100-0-100 microamp (M32, M49, and M56 are interchangeable)	*M32, M49 or M56	
S1	Switch, power	ST5	
S2	Switch, range	*801B-804 *803B-812	A B
S3	Switch, null	*825A-801 *825A-812	A B
S4	Switch, operate-calibrate	*801B-807 *801B-828	A B
S5	Switch, polarity	*801B-806 *801B-827	A B
S6	Switch, voltage dial A	*801B-801 *801B-819	A B
S7, S8, S9	Switch, voltage dials B, C, and D	*801B-802 *801B-820	A B
S10	Switch, voltage dial E	*801B-803 *801B-821	A B
DS1, DS2, DS3, DS4	Lamps, decimal	X2051	
R2	Resistor, variable, dual section wirewound 1K and 100 ohm, 10%, 2W	P1KD	

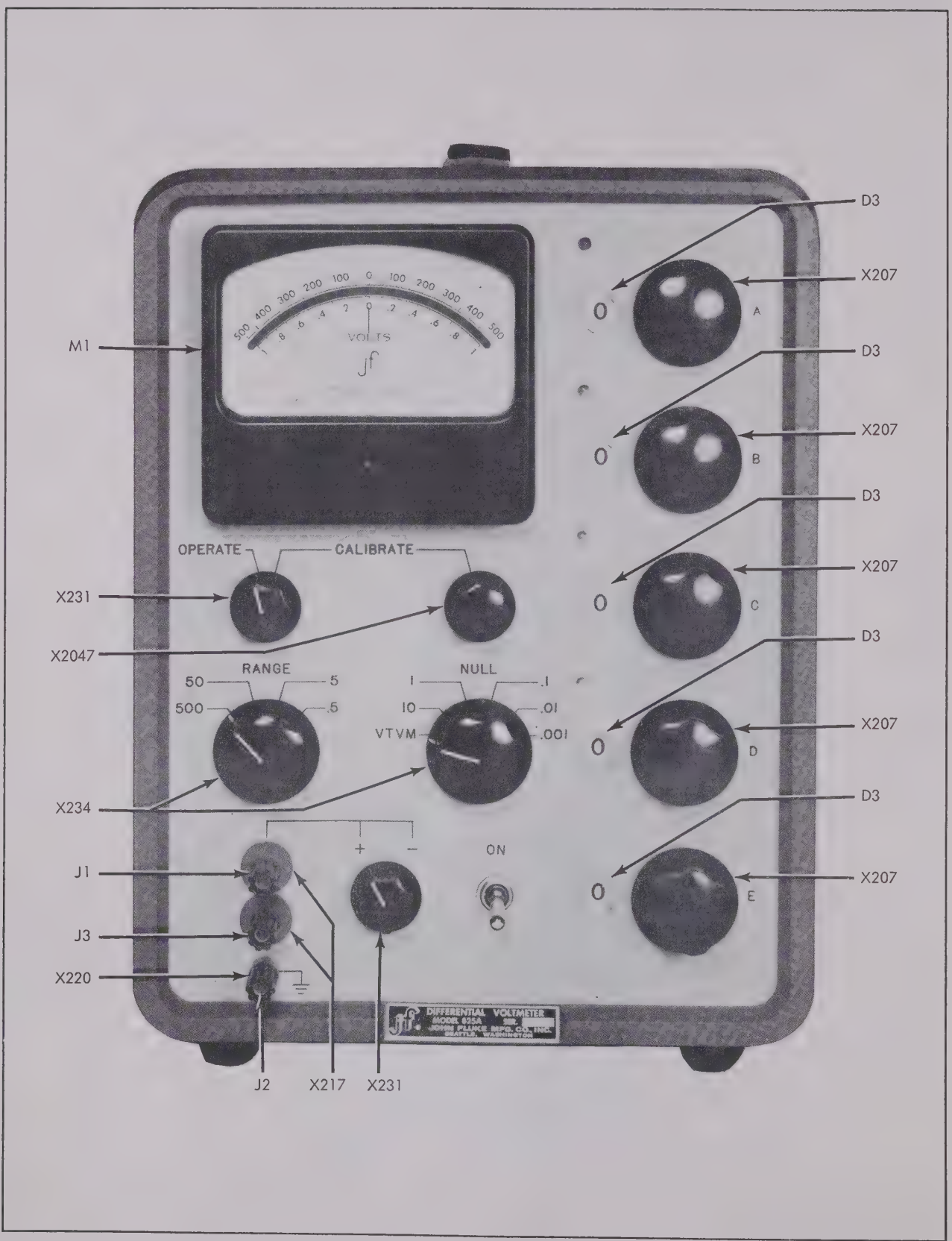


Figure 5-2. FRONT PANEL ASSEMBLY. (Sheet 1 of 2)

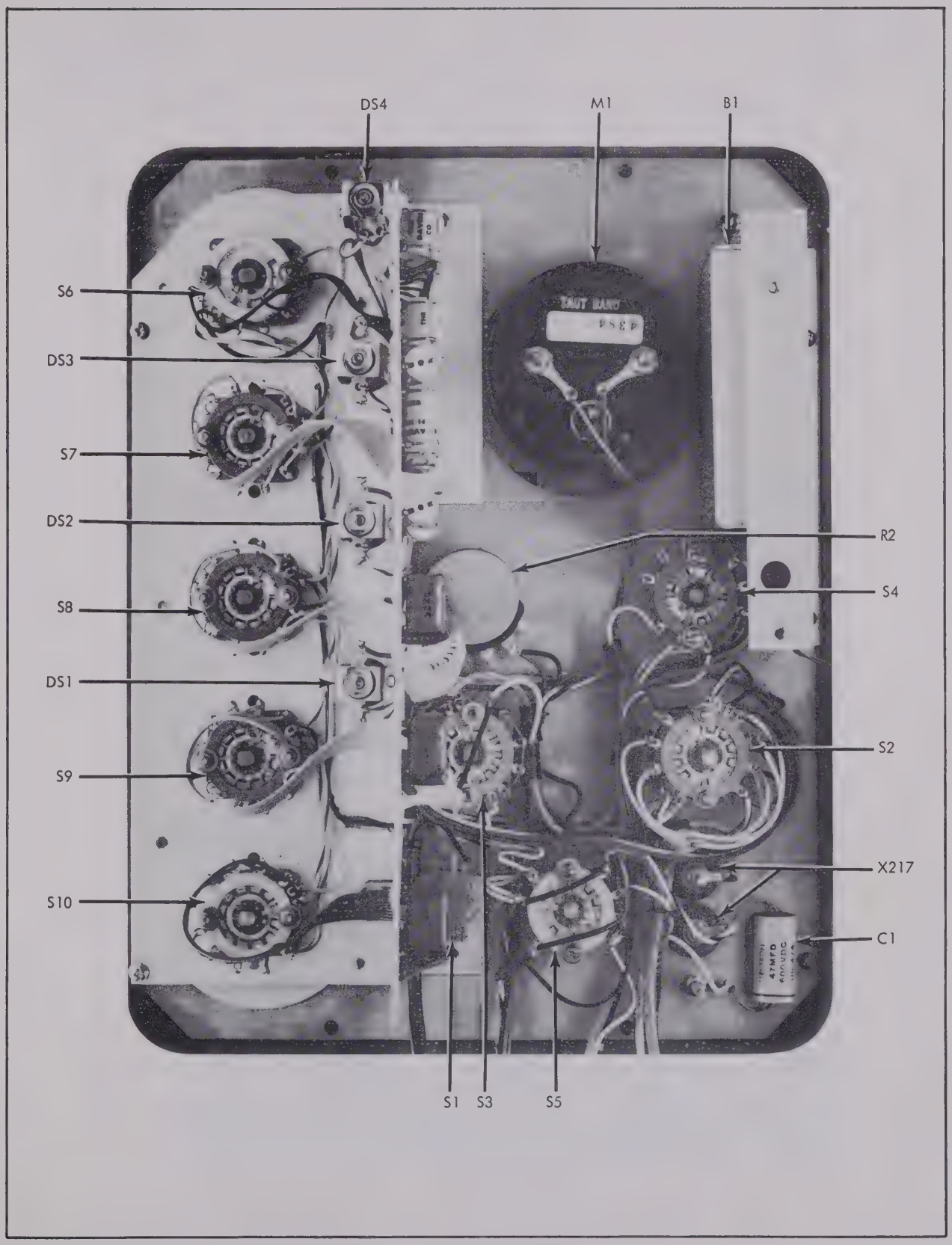


Figure 5-2. FRONT PANEL ASSEMBLY. (Sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Reference Supply Printed Circuit Board Assembly Without Tubes	*801B-401 *801B-423	C D
C101, C102	Capacitor, electrolytic, 20 uf, -10/+100%, 500V	CE52	
C103	Capacitor, paper, 0.1 uf, 20%, 400V	CP4	
C104	Capacitor, mylar, 0.033 uf, 20%, 600V	CF19	
C105	Capacitor, mylar, 0.1 uf, 20%, 600V	CF20	
C106	Capacitor, electrolytic, 1500 uf, -10/+150%, 16V	CE79	D
CR101 thru CR103	Diode, silicon, 0.750 Amp, 600 PIV	RE18	C
CR101 thru CR104	Diode, silicon, 0.750 Amp 600 PIV	RE18	D
Q101	Transistor, germanium PNP, 2N301W	2N301W	D
Q102	Transistor, germanium PNP, 2N1372	2N1372	D
R101	Resistor, wirewound, 10Ω, 5%, 10W	R10WA	C
R101	Resistor, deposited carbon, 5K, 1%, 1/2W	DR49	D
R102	Resistor, composition, 1 Meg, 10%, 1/2W	EB1051	C
R102	Resistor, deposited carbon, 62K, 1%, 1/2W	DR817	D
R103	Resistor, composition, 1 Meg, 10%, 1/2W	EB1051	
R104	Resistor, composition, 220K, 10%, 1/2W	EB2241	
R105, R106	Resistor, composition, 270K, 10%, 1W	GB2741	
R107	Resistor, composition, 22 Meg, 10%, 1/2W	EB2261	
R108	Resistor, composition, 15 Meg, 10%, 1/2W	EB1561	
R109	Resistor, composition, 10 Meg, 10%, 1/2W	EB1061	
R110	Resistor, 100K, 10%, 1W	GB1041	
R111	Resistor, wirewound, 140K, 3%, 10W	R140KW	
R112	Resistor, composition, 100K, 10%, 1/2W	EB1041	
R113	Resistor, composition, 560K, 10%, 1W	GB5641	
R114	Resistor, composition, 220K, 10%, 1/2W	EB2241	
R115	Resistor, composition, 330Ω, 10%, 1/2W	EB3311	
R116	Resistor, composition, 220K, 10%, 1W	GB2241	
R117	Resistor, composition, 82K, 10%, 1/2W	EB8231	
R118	Resistor, composition, 560K, 10%, 1W	GB5641	
R119	Resistor, wirewound, 386K, 0.5%, 1W	PR641	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R120	Resistor, wirewound, 76K, 0.5%, 1/2W	PR59	
R121	Resistor, variable, wirewound, 5K, 20%, 1-1/4W	P5KM	
V101	Vacuum tube, filament regulator, 9-7	9-7	C
V102	Vacuum tube, pentode, EL84/6BQ5	EL84/6BQ5	
V103	Lamp, neon glow, NE2E	X40B	
V104	Vacuum tube, voltage reference, OG3-2	*OG3-2	
V105	Vacuum tube, duo triode, 12AX7	12AX7	
V106	Vacuum tube, duo triode, 12AX7	12AX7	

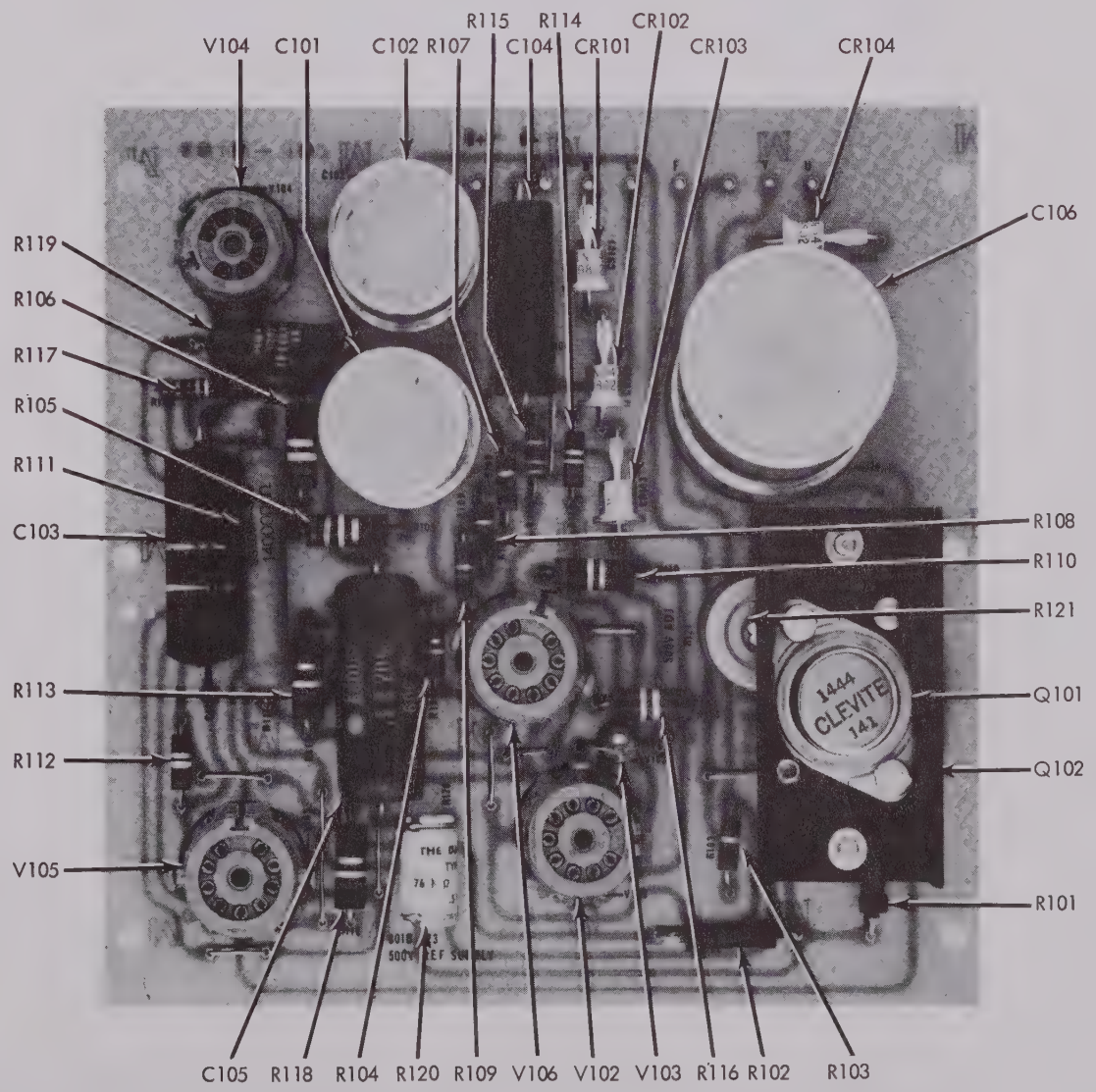


Figure 5-3. REFERENCE SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Null Detector Assembly without tubes	*825A-408	
C201, C202	Capacitor, mylar, 0.1 uf, 20%, 100 V	CF49	
C203	Capacitor, paper, 0.047 uf, 20%, 400 V	CP6G	
C204 ABC	Capacitor, electrolytic, 40-20-20 uf, -10/+100%, 250V	CE35	
C205	Capacitor, mylar, 0.1 uf, 20%, 200V	CF46	
C206	Capacitor, electrolytic, 100 uf, -10/+100%, 3V	CE60	
C207	Capacitor, ceramic, 0.005 uf, 20%, 500V	CT17	
C208	Capacitor, mylar, 0.1 uf, 20%, 200V	CF46	
C209	Capacitor, mylar, 0.47 uf, 20%, 200V	CF48	
C210	Capacitor, mylar, 0.1 uf, 20%, 200V	CF46	
C211	Capacitor, electrolytic, 5 uf, -10/+100%, 50V	CE75	
C212	Capacitor, electrolytic, 500 uf, -10/+100%, 3V	CE61	
C213 AB	Capacitor, electrolytic, 20-20 uf, -10/+50%, 450V	CE5	
C214	Capacitor, electrolytic, 2000 uf, -10/+100%, 25V	CE25	
C215	Capacitor, electrolytic, 30 uf, -10/+100%, 15V	CE74	
C216	Capacitor, electrolytic, 15 uf, -10/+150%, 6V	CE36	F
CR201	Diode, silicon, type IN547, 0.75 Amp, 600 PIV	RE18	
CR202	Diode, silicon, type 2E4, 300 ma, 400 PIV	2E4	
CR203	Diode, silicon, type IN547, 0.75Amp, 600 PIV	RE18	
CR204, CR205	Diode, silicon, type 2E4, 300 ma, 400 PIV	2E4	F
G1	Chopper, electronic, 94 cycle, SPDT	X2058	
	Chopper drive unit, 96 cycle	X2059	
Q201	Transistor, germanium PNP, 2N301W	2N301W	
Q202	Transistor, germanium PNP, 2N1372	2N1372	
R201 through R203	Resistor, composition, 820K, 10%, 1/2W	EB8241	
R204	Resistor, composition, 2.2 Meg, 10%, 1/2W	EB2251	
R205	Resistor, composition, 22K, 10%, 1/2W	EB2231	
R206	Resistor, composition, 150K, 10%, 1/2W	EB1541	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R207	Resistor, composition, 4.7K, 10%, 1/2W	EB4721	
R208	Resistor, composition, 10 Meg, 10%, 1/2W	EB1061	
R209	Resistor, composition, 10K, 10%, 1/2W	EB1031	
R210	Resistor, composition, 220K, 10%, 1/2W	EB2241	
R211, R212	Resistor, composition, 1 Meg, 10%, 1/2W	EB1051	
R213	Resistor, composition, 180K, 10%, 1/2W	EB1841	
R214	Resistor, composition, 1K, 10%, 1/2W	EB1021	
R215	Resistor, composition, 3.3 Meg, 10%, 1/2W	EB3351	
R216	Resistor, composition, 1.5 Meg, 10%, 1/2W	EB1551	
R217	Resistor, composition, 4.7K, 10%, 1/2W	EB4721	
R218	Resistor, composition, 22K, 10%, 1/2W	EB2231	
R219	Resistor, composition, 220Ω, 10%, 1/2W	EB2211	
R220	Resistor, deposited carbon, 10Ω, 1%, 1/2W	DR825	
R221	Resistor, deposited carbon, 75Ω, 1%, 1/2W	DR23	
R222	Resistor, wirewound, variable, 500Ω, 10%, 2W	P500A	
R223, R224	Resistor, composition, 1.8K, 10%, 1/2W	EB1821	
R225, R226	Resistor, composition, 47K, 10%, 2W	HB4731	
R227	Resistor, composition, 2.2K, 10%, 2W (This resistor replaces 2.7K resistor, HB2721, used in earlier models. If replacement is required, use HB2221.)	HB2221	
R228	Resistor, composition, 560K, 10%, 1/2W	EB5641	
R229	Resistor, composition, 560Ω, 10%, 1/2W	EB5611	
R230	Resistor, composition, 2.2K, 10%, 2W (This resistor replaces 2.7K resistor, HB2721, used in earlier models. If replacement is required, use HB2221.)	HB2221	
R231	Resistor, composition, 180K, 10%, 1/2W	EB1841	
R232	Resistor, wirewound, variable, 10K, 20%, 2W	P10KA	
R233	Resistor, composition, 100K, 10%, 1/2W	EB1041	
R234	Resistor, deposited carbon, 2.7K, 1%, 1/2W	DR415	
R235	Resistor, deposited carbon, 31.6K, 1%, 1W	DR826	
V201	Lamp, neon glow, type NE2E	X40B	
V202	Vacuum tube, duo triode, 5751	5751	
V203	Vacuum tube, triode-pentode, 6AW8A	6AW8A	
V204	Vacuum tube, voltage reference, OA2	OA2	

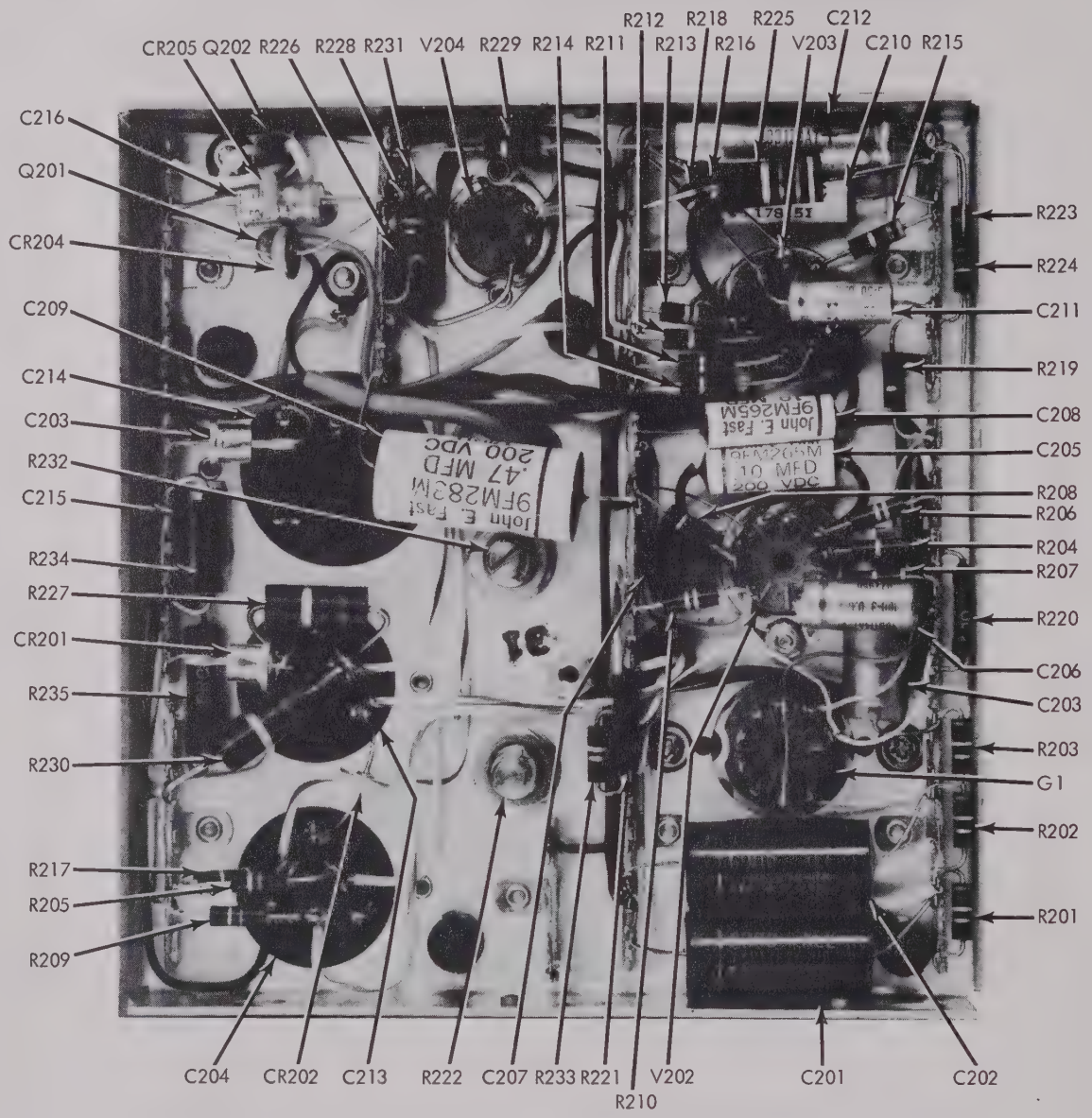


Figure 5-4. NULL DETECTOR CHASSIS ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Range Resistor Printed Circuit Board Assembly	*825A-405 *825AR-421 *825A/G-406 *825AR/G-424	
C301	Capacitor, mylar, 1 uf, 20%, 600V	CP33	
C302	Capacitor mylar 2 uf, 20%, 200V	CF51	
CR301	Zener diode (825A/AG and 825AR/AG) If replacement is required it will be necessary to replace both CR301 and R319 with Zener resistor pair 825A/G-426. In some cases, it may also be necessary to replace R3. This will be determined at the factory		
R301 thru R304	Resistor, deposited carbon, 10 Meg, 1% 1W	DR80	
R305	Resistor, deposited carbon, 9 Meg, 1%, 1W	DR78	
R306	Resistor deposited carbon 900K, 1%, 1/2W	DR622	
R307	Resistor, deposited carbon, 90K, 1%, 1/2W	DR513	
R308	Resistor deposited carbon, 9K, 1%, 1/2W	DR412	
R309	Resistor, deposited carbon, 900Ω 1%, 1/2W	DR824	
R310	Resistor, deposited carbon 100Ω, 1%, 1/2W	DR35	
R311 thru R315	Resistor, composition, 22 Meg, 10%, 1/2W	EB2261	
R316, R317	Resistor, wirewound, 125K, 0.1%, 1W	PR610	
R318	Resistor, variable, wirewound, 1K, 20%, 1-1/4W (825A and 825AR) Resistor, variable wirewound, 3K, 10%, 1-1/4W (825A/AG and 825AR/AG)	P1KM P3KM	
R319	Resistor, wirewound, 511.7Ω, 0.1%, 1/2W (825A and 825AR) Resistor wirewound (825A/AG and 825AR/AG) Optimum value is selected at factory to match Zener diode. When ordering, include date and serial number listed on Range Resistor Printed Circuit Board.	PR643	
R320, R321	Resistor, wirewound, 112.375K, 0.05% 1W	PR615	
R322	Resistor, composition, 27K 10%, 1W	GB2731	
R323	Resistor, variable, 500Ω 10%, 1-1/4W	P500M	
R324	Resistor wirewound, 28.571K, 0.05%, 1/2W	PR515	
R325	Resistor wirewound, 22.5K, 0.1% 1/2W	PR513	
R326	Resistor variable, 500Ω, 10%, 1-1/4W	P500M	
R327	Resistor wirewound 2531.7Ω, 0.05%, 1/2W	PR49	
R328	Resistor, wirewound, 24.75K, 0.1%, 1/2W	PR514	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R329	Resistor, variable, 500Ω, 10%, 1-1/4 W	P500M	
R330	Resistor, wirewound, 250.31Ω, 0.05%, 1/2 W	PR311	
R331	Resistor, composition, 270Ω, 10%, 1/2 W	EB2711	
R332	Resistor, composition, 100K, 10%, 1/2 W, located on OPERATE-CALIBRATE switch (825A/AG and 825AR/AG)	EB1041	
R333	Resistor, composition, 820K, 10%, 1/2 W, located on OPERATE-CALIBRATE switch (825A/AG and 825AR/AG)	EB8241	

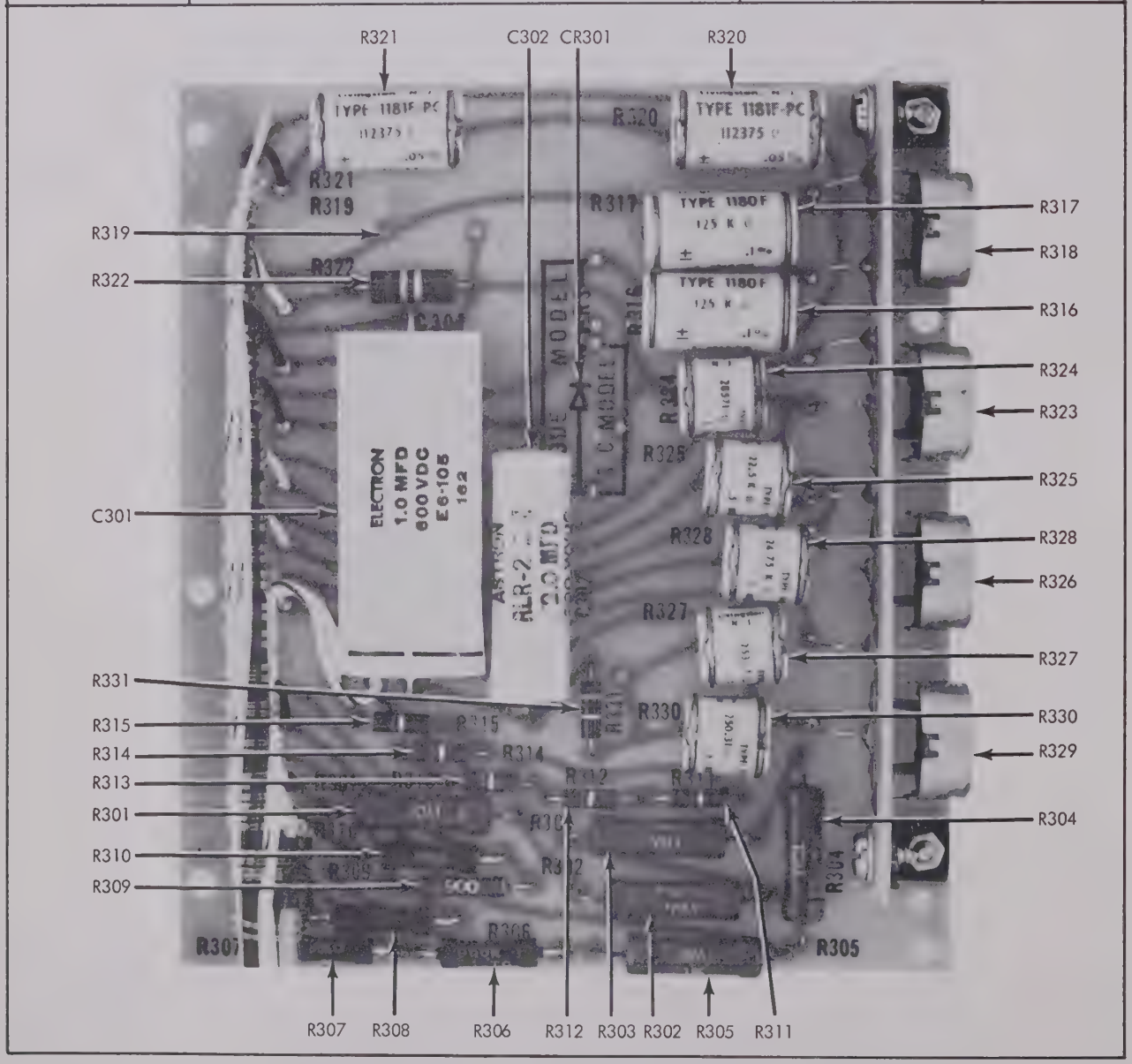


Figure 5-5. RANGE RESISTOR PRINTED CIRCUIT BOARD ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Kelvin-Varley Resistor Board Assembly	*801B-403	
R401 thru R406**	Resistor, wirewound, 40K ±0.02%, 1/2W	*PR512	
R407 thru R417**	Resistor, wirewound, 8K ±0.02%, 1/2W	*PR48	
R418 thru R428**	Resistor, wirewound, 1.6K ±0.01%, 1/8W	*34-2121	
R429 thru R439**	Resistor, wirewound, 320Ω ±0.1%, 1/2W	*PR39	
R440 thru R449	Resistor, wirewound, 64Ω ±0.1%, 1/2W	*PR24	

**These resistors are factory matched for each instrument. When ordering, specify instrument serial number.

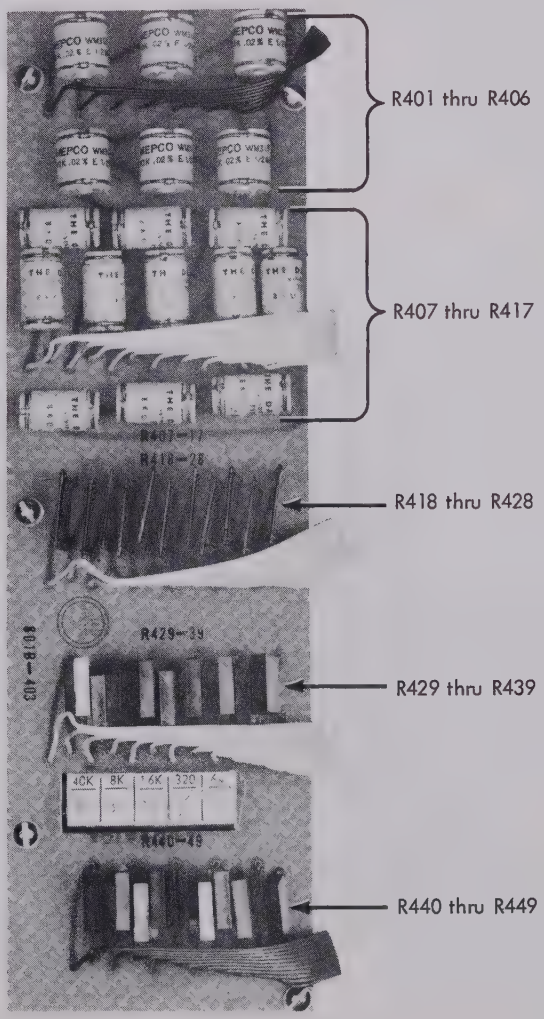


Figure 5-6. KELVIN-VARLEY RESISTOR BOARD ASSEMBLY

USE CODE EFFECTIVITY

The following list of use codes is intended to allow the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments with serial numbers above 123. New codes will be added as necessary on forthcoming instruments.

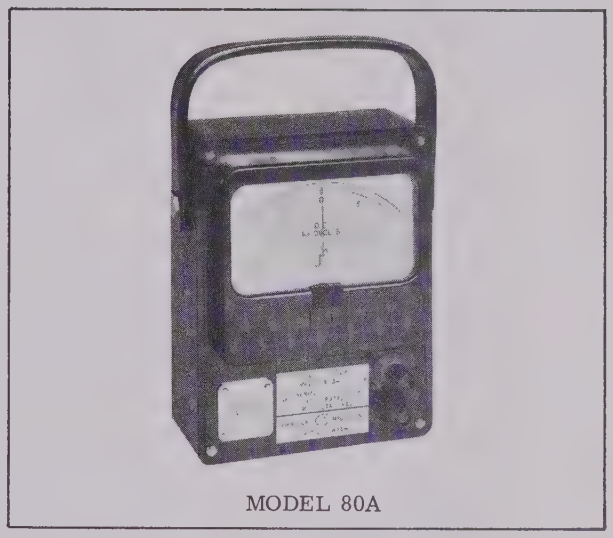
USE CODE	EFFECTIVITY
No Code	Model 825A serial number 123 and on Model 825AR serial number 123 and on Model 825A/AG serial number 123 and on Model 825AR/AG serial number 123 and on
A	Model 825A serial number 123 thru 309 Model 825AR serial number 123 thru 213 Model 825A/AG serial number 123 thru 309 Model 825AR/AG serial number 123 thru 213
B	Model 825A serial number 310 and on Model 825AR serial number 214 and on Model 825A/AG serial number 310 and on Model 825AR/AG serial number 214 and on
C	Model 825A serial number 123 thru 379 Model 825AR serial number 123 thru 233 Model 825A/AG serial number 123 thru 379 Model 825AR/AG serial number 134 thru 233
D	Model 825A serial number 380 and on Model 825AR serial number 234 and on Model 825A/AG serial number 380 and on Model 825AR/AG serial number 234 and on
E	Model 825A serial number 123 thru 352 Model 825AR serial number 123 thru 223 Model 825A/AG serial number 123 thru 352 Model 825AR/AG serial number 123 thru 223
F	Model 825A serial number 353 and on Model 825AR serial number 224 and on Model 825A/AG serial number 353 and on Model 825AR/AG serial number 224 and on
G	Model 825A serial number 123 thru 669 Model 825AR serial number 123 thru 308 Model 825A/AG serial number 123 thru 669 Model 825AR/AG serial number 123 thru 308
H	Model 825A serial number 670 and on Model 825AR serial number 309 and on Model 825A/AG serial number 670 and on Model 825AR/AG serial number 309 and on
I	Model 825A serial number 123 thru 909 Model 825AR serial number 123 thru 373 Model 825A/AG serial number 123 thru 909 Model 825AR/AG serial number 123 thru 373
J	Model 825A serial number 910 and on Model 825AR serial number 374 and on Model 825A/AG serial number 910 and on Model 825AR/AG serial number 374 and on

SECTION VI

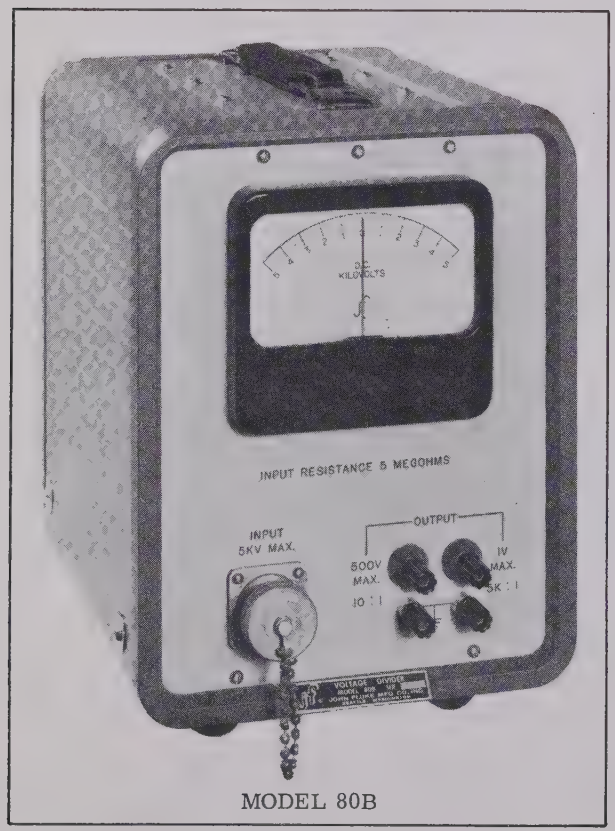
ACCESSORIES

6-1. PRECISION VOLTAGE DIVIDERS

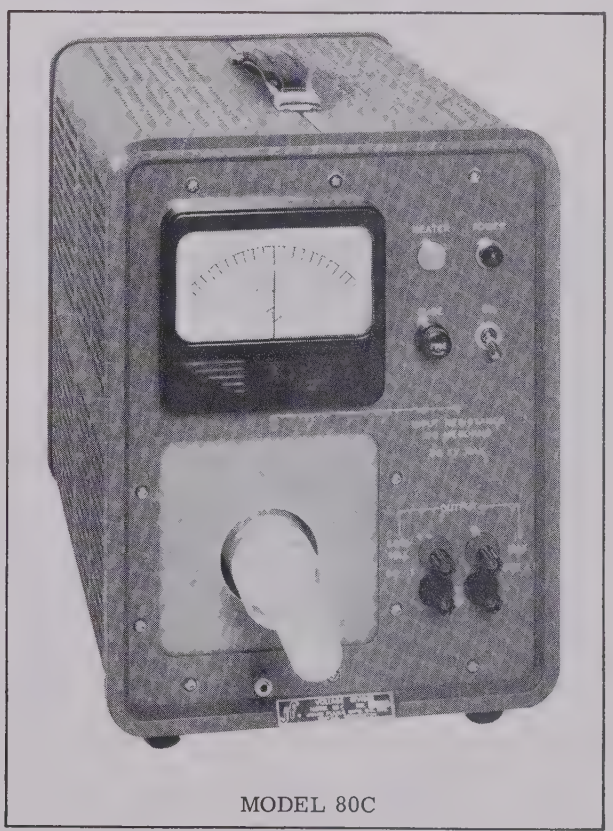
The Fluke 80A, 80B, and 80C Precision Voltage Dividers provide the ℱ 800 Series Differential Voltmeters with the ability to make high accuracy measurements up to 30,000 volts DC. All models contain a zero center panel meter which allows the polarity and approximate magnitude of the unknown high voltage to be easily observed. At maximum input, all units draw but 1 ma of current from the unknown. The extreme accuracy and excellent long term stability of these dividers are obtained by using properly aged precision wirewound resistors which have a very low temperature coefficient. To further ensure high accuracy and long term stability at very high voltages, the 80C dividers have all resistance components immersed in oil within a hermetically sealed container. As an additional feature, all 80B and 80C models are provided with a 1 volt tap which allows measurements of high voltages with a laboratory potentiometer. Specifications for the standard models are shown on next page. Other intermediate models are available upon special request.



MODEL 80A



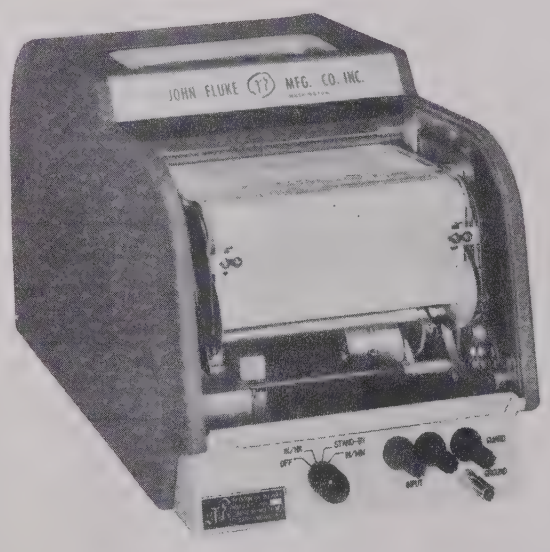
MODEL 80B



MODEL 80C

Model No.	Maximum Input Voltage	Total Resistance	Current Drawn At Max. Input	Division Ratio		Division Accuracy	Stability of Division Accuracy Per Year	Temp. Coef. of Division Ratio
				500 V Out	1 V Out			
80A-1 80A-2	1 KV 2 KV	1 M 2 M	1 ma	2:1 4:1	—— ——	±0.015%	——	——
80B-5 80B-10	5 KV 10 KV	5 M 10 M	1 ma	10:1 20:1	5,000:1 10,000:1	±0.01%	±0.005%	±0.005%/°C from 0°C to 60°C
80C-15 80C-20 80C-25 80C-30	15 KV 20 KV 25 KV 30 KV	15 M 20 M 25 M 30 M	1 ma	30:1 40:1 50:1 60:1	15,000:1 20,000:1 25,000:1 30,000:1	±0.01%	±0.0005%	±0.0002%/°C from 0°C to 35°C

MODELS	SIZE	INPUT CONNECTOR	OUTPUT CONNECTOR
80A	6-3/4" high 5-1/4" wide 2-1/4" deep	UG-560U with mating connector supplied	Insulated binding posts on 3/4" centers
80B	10-9/32" high 8" wide 10" deep	AN3102-18-165 with mating connector supplied	Insulated binding posts on 3/4" centers for both outputs
80C	13" high 9-3/4 " wide 16" deep	Special 5" ceramic standoff with mating 8" polystyrene connector supplied	Insulated binding post on 3/4" centers for both outputs



MODEL A-70 POTENTIOMETRIC RECORDER

6-2. POTENTIOMETRIC RECORDER

The Fluke Model A-70 Self Balancing Potentiometric Recorder is a special purpose high sensitivity recorder developed for monitoring voltages measured by the ® 800 Series Differential Voltmeters. In addition to providing a permanent record of results, the recorder allows unattended monitoring of various voltages from 0 to 500 volts for long periods of time. A sample voltage which varies in direct proportion to the source under measurement is obtained from the voltmeter null detector by connecting the recorder to the output terminals at the rear of the voltmeter. A gain adjustment control adjacent to the voltmeter output terminals allows the sample voltage to be adjusted such that full-scale meter deflection equals full-scale recorder deflection. The large leakage resistance (500,000 megohms) between the recorder input posts and chassis is such that the inherently high accuracy of the Fluke Differential Voltmeter is generally not impaired in any way.

Electrical Span:	10 mv DC
Span Step Response Time:	Less than 0.5 seconds
Accuracy:	0.5% of span
Chart Speeds:	0.75, 1.5, 3.6, or 12 in./min. or in./hr.
Dimensions:	Cabinet Model - Cabinet Model--9-1/4" high, 8-1/4" wide, 15" deep. Rack Model--Available on special request.

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

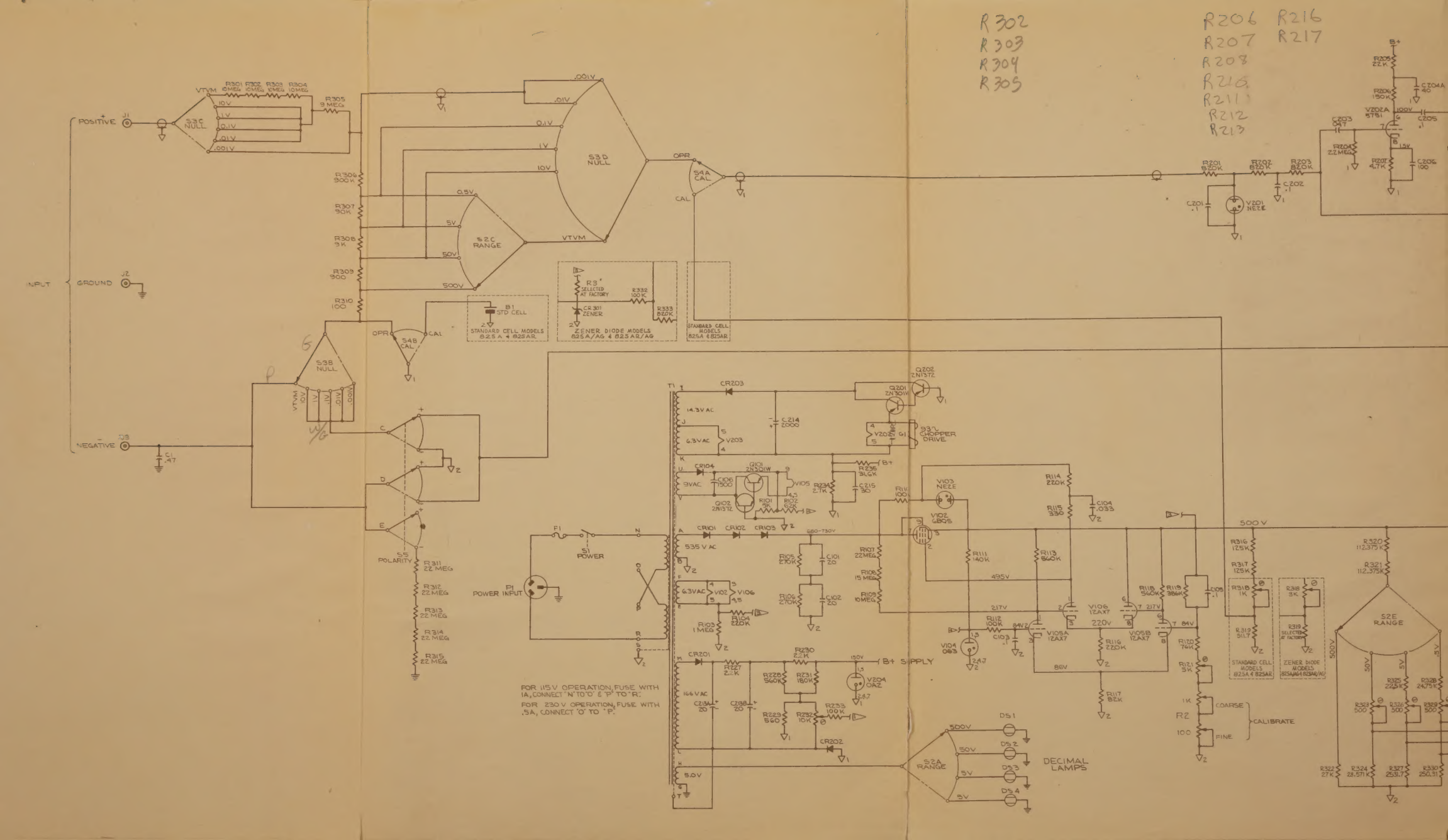
All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

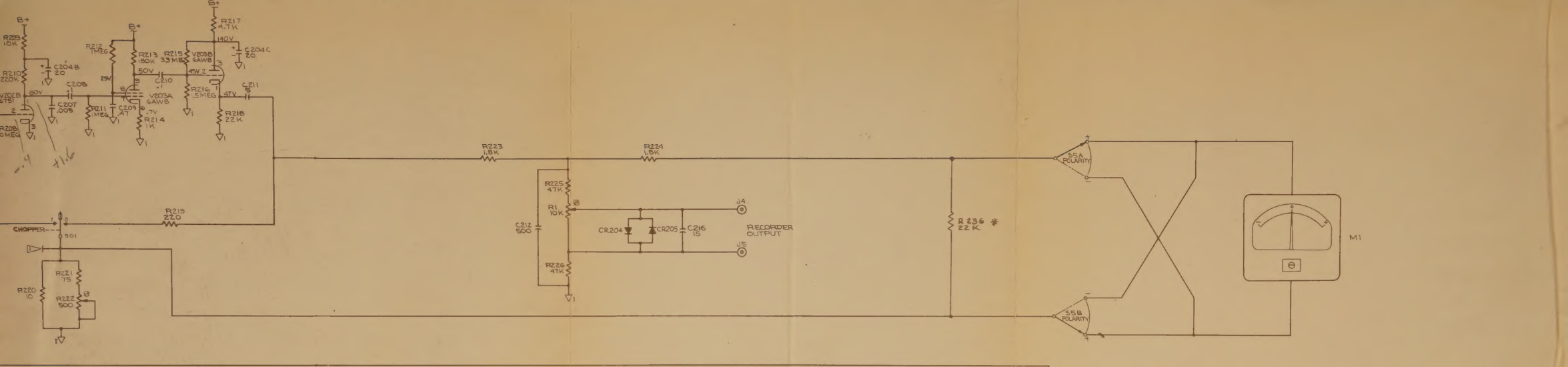
CLAIM FOR DAMAGE IN SHIPMENT

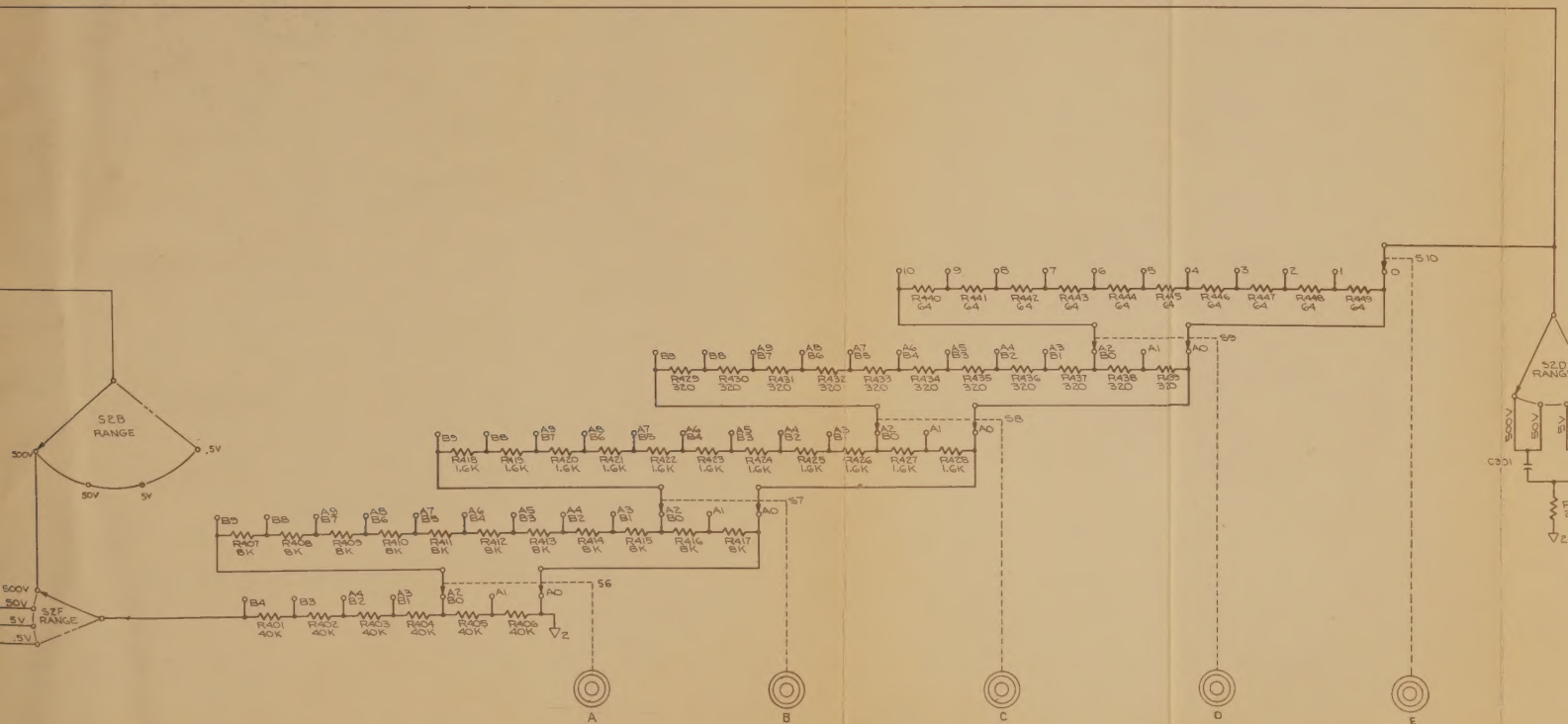
The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON


R302
R303
R304
R305
R206 R216
R207 R217
R208
R210
R211
R212
R213
POSITIVE
NEGATIVE
INPUT
GROUND
VTVM
S3C NULL
S3D NULL
S2C RANGE
S4A CAL
S4B CAL
S3B NULL
S5 POLARITY
S1 POWER
P1 POWER INPUT
B1 STD CELL
STANDARD CELL MODELS 825A & 825AR
ZENER DIODE MODELS 825A/AG & 825AR/AG
CHOPPER DRIVE
B+ SUPPLY
FOR 115 V OPERATION, FUSE WITH 1A, CONNECT "N" TO "O" & "P" TO "R".
FOR 230 V OPERATION, FUSE WITH .5A, CONNECT "O" TO "P".
S2A RANGE
DECIMAL LAMPS
S2E RANGE
COARSE
FINE
CALIBRATE





NOTES

1. All voltage measurements shown are taken under the following conditions:
   (a) RANGE switch set to 500.
   (b) NULL switch set to VTVM.
   (c) All voltage readout dials set to zero.
   (d) Polarity switch set to +.
   (e) Line voltage at 115/230 volts, 50-400 cycles.
   (f) All measurements made with a VTVM (10 megohms input resistance) to the negative binding post.
2. All voltages are DC unless otherwise indicated.
3. $\perp_{V_1}$ Indicates null detector common.
4. $\perp_{V_2}$ Indicates reference supply common.
5. $\perp_{V_1}$ and $\perp_{V_2}$ may differ in voltage by amount indicated on voltage readout dials.
6. ▷ All flagnotes with the same number are connected.
7. ⊘ Indicates internal adjustment.
8. Unless otherwise indicated, resistances are in ohms and capacitances are in microfarads.
9. * INDICATES MAY BE OMITTED.

825A & 825A/AG SER 380 & ON
825AR & 825AR/AG SER 234 & ON

FUNCTIONAL SCHEMATIC
DIFFERENTIAL VOLTMETER
MODEL
825A, 825AR, 825A/AG, & 825AR/AG

JOHN FLUKE MANUFACTURING COMPANY
MOUNTLAKE TERRACE, WASHINGTON

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